Naturalness in scripts and writing systems

Outlining a Natural Grapholinguistics

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to Petra

Statutory declaration

I declare that I have authored this thesis independently, that I have not used sources other than the declared sources and that I have explicitly marked all material which has been quoted either literally or by content from the used sources.

Date

Dimitrios Meletis

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* Studies such as: Qureshi, Adnan I. et al. (2009): Cat ownership and the risk of fatal cardiovascular diseases. Results from the second national health and nutrition examination study mortality follow-up study. *Journal of Vascular and Interventional Neurology* 2.1: 132-135.

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Introduction

> […] written language is yet another manifestation of the natural endowment of the human mind and may not be treated as a proxy for speech […].
> (Aaron & Joshi 2006: 263)

> Our writing systems changed under the constraint that even a primate brain had to find them easy to acquire. (Dehaene 2009: 150)

Writing is an invention and a cultural technology that changed humankind and continues to exert a massive influence on it. This is true to such a degree that it is almost impossible to overstate the relevance of writing in modern societies. When, in one of my classes on grapholinguistics, I asked students to imagine what their everyday lives would look like without writing, they simply couldn't. In literate communities, a life without writing appears almost unthinkable. As a mode of communication fundamentally different from speech, it fulfills a myriad of specific functions, and in the recent past, the contexts in which writing is used have only multiplied: thanks to digitalization, writing is a convenient and easy way of communicating, and as is aptly evident in the cases of messenger services, social media, etc., it is strikingly flexible when it comes to degrees of formality or registers. Conceptually, the lines between written/literate and spoken/oral are increasingly blurred (for the conceptual dimension of written vs. spoken, cf. Koch & Oesterreicher 1994). Writing is also a deeply social and personal matter. Through writing – be it a special style of handwriting, the use of a specific font, the choice of words in writing or any of its other highly variable aspects – one can convey their identity. Writing, to everyone who is literate, is perceived as a skill intimately tied to oneself, and in a community, it is regarded as a common good. It is not surprising, then, that matters of writing are frequently debated quite heatedly: take as examples discourses on orthography reforms, the abolishment of cursive handwriting in early literacy instruction or the discussion whether emojis are written words. Writing has evidently ceased to stand in the shadow of spoken language. It is not a conservative technique reserved for scribes of the elite. It is an intricate part of many lives, and linguistically speaking, it is a locus, and sometimes even the initiator, of change and innovation.

The treatment of writing in linguistics gives an utterly different picture. In linguistics, writing has always existed in the margins. Until recently, that is. As Baroni (2016: 291) observes, "[m]ost linguists, when dealing with graphemics, written language, writing systems and orthography, feel the need to justify themselves. It is about time to change this attitude and to stop feeling guilty about treating graphemics as part of linguistics". The change of attitude he writes about, it seems, has slowly arrived: in the last couple of decades, the investigation of various aspects of writing has become gradually more accepted. The slow emergence of an interdisciplinary field called *Schriftlinguistik*, English *grapholinguistics*, is an immediate result of this. However, despite the growing interest in the subject, the late acceptance of writing to the list of linguistic matters reflects itself in the degree of development of this young discipline. This is most drastically palpable in the lack of communication between the disciplines interested in writing – and they are many: linguistics, psychology, cognitive sciences, pedagogy, art history, philosophy, history, and many others – or even different cultural communities of the same disciplines, e.g. the Angloamerican linguistic community and the German-speaking linguistic community. As a consequence, there is a lack of theory. Many aspects of writing have been brilliantly illuminated, including a large portion of its history, or the structural description of the major (and many minor) writing systems of the world. However, the results of individual achievements are often not put into perspective and remain unconnected to related findings. This hinders the development of a theory of writing, and with it, what is still sorely lacking are basic concepts and terminology that would allow a comparison of different writing systems. The concepts and models that do exist are largely Eurocentric (cf. Yan 2002), an old shoe of a criticism that, alas, still fits. In the realm of psychology, Share (2014) still speaks of an "alphabetism in reading science". And not only in psychology, but also in other grapholinguistic areas is the aftertaste of an alleged superiority of the alphabet still tastable.

The lack of a grapholinguistic theory has at times been lamented. Two decades ago, one of the most fervent observers of research on writing, W. C. Watt, wrote in a review of the arguably most important edited volume on the writing systems of the world (Daniels & Bright 1996) that he wished for 'more', and he went on to explain what that entailed:

> 'More' would constitute, or at least contribute to, a semiotic theory of writing systems: a theory that would explain, to put it pithily, why each such writing system is the way it is, instead of some other way, and why all such systems have in common what they have in common. Such a theory might begin by examining the *nature* of the problem facing anyone who wishes to record a spoken language, competently addressing the question of how speech is most *naturally* segmented in relation to how it is most *naturally* or most easily translated into visible marks. Such a theory might proceed to examine the purely physical factors that determine the forms of writing systems: the *nature* of available writing materials and the *nature* of the pertinent human physiology, especially that of hand and eye. [...] Such a theory might continue by examining the cognitive factors that determine the forms of writing systems: the human disposition to generalize and/or to misremember in certain directions rather than others, for instance. Any such theory would, of course, if successful at the tasks just set forth, also largely explain how one writing system can 'evolve' into another, in an appropriate sense of that much-vexed term 'evolve'.
> (Watt 1998: 118, my emphasis)

Watt's observations call for a shift from description to explanation. It is not sufficient anymore to describe certain aspects of writing, or even entire writing systems, without integrating the findings into a larger theoretical framework and seeking explanations. It is this framework that is still lacking, and it is this framework that the present thesis wants to establish.

A first step that needs to be taken towards a theory of writing is to broaden the horizon. Writing systems of vastly different languages, both genetically and typologically, must be considered, and it must be evaluated if and how universal categories can be defined that suit all of them. By means of comparison of different writing systems, commonalities and differences must be established. In this context, similarities that show themselves universally are of greatest relevance: to explain them, one must look at the acts of writing and reading. The structure of scripts, as inventories of visual marks (e.g. Cyrillic script), and writing systems, the systems relating these visual marks to language (e.g. Russian writing system), is subject to human pressure. It is influenced by the fact that prototypical readers and writers are equipped with brains, eyes, hands, and a need or wish to communicate. The structure of writing, thus, is a reflection of how humans shaped it, and in the establishment of a theory of writing, it is paramount to reconstruct how exactly human conditions and writing interact. It is at this point that a theory of writing does not need to be established from scratch, but can build on existing theories of language, and one in particular: Naturalness Theory.

Naturalness Theory is a theoretical framework consisting of several approaches that share the core view that the nature of humans – this includes their physiology, cognition, and socialization – shapes the structure of language. Natural Phonology, as the original branch of the theory, claims the existence of processes that facilitate articulation and perception of speech by eliminating difficulties. These processes are termed natural since they are based in human physiology, i.e. what is easy to speak with our mouths, lips, etc., to hear with our ears, and to process with our brains. A second influential branch of the theory, Natural Morphology, transferred these core ideas to morphology and proposed that the semiotic structure of morphemes – as signs – has a bearing on human cognition. This led to a list of naturalness parameters describing aspects of the semiotic structure of morphemes that were claimed to be relevant in cognitive processing. In both, Natural Phonology and Natural Morphology, *natural* pertains to human nature and is a scalar, evaluative attribute that is ascribed to those features of language that are relatively easier to process than others. Note how Watt, in his quote above, probably oblivious to Naturalness Theory, used the words "naturally" and "nature" in ways that fit perfectly into a naturalist paradigm; as I will show in the course of this thesis, many grapholinguistic works were implicitly naturalist and match the theoretical framework even if the authors of those works are not conscious of this. Naturalness Theory shares commonalities with many other linguistic theories, including Markedness Theory, Optimality Theory, and Usage-based linguistics, but in its striving for an extralinguistic explanation for linguistic data, it serves as an especially suitable source for a theoretical framework for grapholinguistics. An extension of Naturalness Theory to writing is predicted to be capable of achieving many of the things listed by Watt as desiderata in the quote above – in a nutshell, explaining "why each writing system is the way it is". However, I want to note that I am not a fervent proponent of any theory, including Naturalness Theory. I am primarily a linguist interested in writing, and for the reasons explained throughout this thesis, I think Naturalness Theory is a suitable framework. I say this to underline that when I encounter shortcomings of the theory, I will point them out. That way, this thesis is not only a proposal of a theory of writing thanks to Naturalness Theory, but also an extension of Naturalness Theory thanks to its application to a domain it was hitherto not applied to.

That Naturalness Theory is a promising framework for the study of writing has been formerly pointed out by Munske (1994) and Baroni (2011), whose preliminary ideas were never developed into a full theory. This is a situation I wish to change with this thesis. In the vein of Stampe's (1973) constitutive work on Natural Phonology, in which he outlined roughly the central tenets of the approach, and Dressler's (1989) sketch of the core semiotic parameters relevant in Natural Textlinguistics (yet another, if minor, branch of the theory), I want to provide the most important cornerstones in a first sketch – *not* a description of a full-fledged theory – of Natural Grapholinguistics. Thus, what this thesis will *not* be is a minute description of any specific writing system, nor a detailed comparison of any two writing systems. It will rather be a proposal of the categories relevant in a theory of writing, and these will be relevant for the description and explanation of individual writing systems as well as cross-grapholinguistic comparison. To achieve this, as was similarly done by Stampe (1973) for phonology and Dressler (1989) for textlinguistics, examples from a variety of the world's writing systems will be given, and, in the vein of naturalist methodology, extralinguistic evidence from different sources – including literacy acquisition and the diachronic development of writing – will be considered. The focus is on the explanation of universal tendencies, but typological aspects specific to certain writing systems will also be discussed. Also, what I want to disclose here, is that most examples stem from modern writing systems, implying that the theory was synchronically oriented. This is only partially true: the theory aims to explain why all writing systems are the way they are, and this includes ancient writing systems no longer in use. The importance of diachrony is underlined by the fact that one of the most important types of explanatory evidence is, as mentioned, the historical development of writing systems. The focus on examples from modern writing systems is due to the fact that for these, other types of evidence – such as highly relevant psycholinguistic evidence – is also available. Another disclaimer pertains to the scope of the concept of naturalness: this thesis is not interested in arguing at length that writing *per se* is natural, which is often contested, most frequently when it is juxtaposed with speech (cf. Section 1.1.2), but an investigation of features that are natural in writing, i.e. *what* about writing is natural.

As the scope of this study appears enormous and the aims ambitious, it is necessary to state explicitly its essential goals. The major question treated in this thesis is what can be regarded as natural in the structures of writing, in other words: which features of writing are natural? Results will be preliminary as it is not possible to take into account all of the world's writing systems in this study. However, a rough framework for the comparison of writing systems and a *tertium comparationis* will be available for future research. This is also where Rogers' (1995: 31) provocative claim that "some writing systems are better than others" comes into play. As he himself noted, this could be debated. Such a debate, however, at least an objective one not tainted by the presumption of the superiority of the alphabet, has failed to materialize. I argue that this is precisely due to the lack of a tertium comparationis. As it will be provided here, this study allows not only an evaluation of single writing systems (e.g. how natural is the

German writing system?) but also the comparison of writing systems with regard to their naturalness of a certain feature (e.g. are the graphemes more natural with regard to transparency in the Italian or in the German writing system?). A byproduct of this study that is of no lesser relevance is that desiderata will be highlighted: it will become obvious where empirical evidence is still lacking. This means that a proposal of Natural Grapholinguistics equals a diagnosis of the current state of the whole interdisciplinary field as it identifies those underrepresented areas in which further research and transdisciplinary exchange are necessary for a theory of writing to stand on firm and even grounds.

The thesis is structured in three comprehensive chapters. Chapter 1 is a detailed description and critical discussion of Naturalness Theory. In its breadth and scope, it is the first of its kind. While the subbranches of Natural Phonology and Natural Morphology, as well as a number of minor naturalist approaches, have often been described, they were most frequently treated in separation, and the question of how the approaches fit into a larger naturalist framework remained largely unanswered. The question of how Natural Phonology and Natural Morphology can be reconciled in a coherent theory is of special relevance for Natural Grapholinguistics: Natural Phonology deals predominantly with the material aspects of spoken language, and explanation is based on human physiology. On the other hand, Natural Morphology deals with the structural level of language, and due to the assumption that structure and cognitive processing are causally associated, it is based on human cognition. Writing, crucially, combines both realms: as its own modality of language and its own semiotic system, it has its distinct graphic and visual materiality – which is to be studied by Natural Graphetics – and its very own semiotic structures – to be treated by Natural Graphematics. To answer the question of whether Naturalness Theory is suitable as a theoretical framework for grapholinguistics, a critical combined view of Natural Phonology, Natural Morphology, and the other naturalist subbranches is necessary. Thus, after Section 1.1 carefully dissects the meanings of *natural* and provides a working definition of *naturalness*, sections on Natural Phonology (Section 1.2) and Natural Morphology (Section 1.3) outline the historical and scientific contexts of these approaches, present their core principles and give first glimpses into how they can be transferred to the domain of writing. In Section 1.4, other subbranches such as Natural Textlinguistics will be outlined briefly. Finally, it is necessary to acknowledge that Naturalness Theory is a theory among other linguistic theories with which it interacts and shares certain features. In Section 1.5, the commonalities and differences of Naturalness Theory and these other theories will be discussed.

Chapter 2 is a detailed description of theoretical grapholinguistics with the aim of establishing a structural and methodological framework that can be applied to all – as opposed to only alphabetic – writing systems. After a reconstruction of the current state of the field, one of the central questions of the linguistic treatment of writing is restated in Section 2.1: what is the relation between language, speech, and writing? Open questions pertaining to this very problem and notions of dependence vs. autonomy are formulated in order to be investigated in the sections that follow. These are structured based on Neef's (2015) multimodular model of writing systems (cf. Section 2.2), which holds that writing systems are based on an underlying language and consist of a script, a graphematic module, and – optionally – an orthographic regulation. Section 2.2.1 deals with the graphetic module and graphetics as the discipline studying it. Various aspects of the materiality of writing and specifically scripts will be discussed. Following Meletis (2015), the different subdisciplines of graphetics, levels of description, and relevant graphetic units will be presented. Section 2.2.2 is the most extensive portion of the chapter as it delves into the graphematic module that links visual units and linguistic units. The core question discussed here is how the infamous and oft-debated concept of *grapheme* can be defined in a more universal manner than previously. Furthermore, the valuable contributions of German grapholinguistics in defining other graphematic units – such as the graphematic syllable, word, or sentence – will be made available to an English audience and simultaneously critically scrutinized with respect to their cross-linguistic applicability. Section 2.2.3 is dedicated to the orthographic module. Since in the English-speaking realm, *orthography* is often misused as a synonym of the descriptive term *writing system*, the truly normative character of orthographies as objects of linguistic policy is often undermined or even completely neglected. This section describes which concepts and factors are central in the standardization of writing systems. To provide a picture of the diversity of both scripts and writing systems, Section 2.3 is focused on typology: on the one hand, the question will be pondered of what a yet non-existent typology of scripts could potentially look like, and on the other, the well-established grapholinguistic subbranch of writing system typology will be presented by showing some of the core typologies that have been proposed in the past. Finally, the epilogue in Section 2.4 takes up the open questions about the speech-writing-relation developed in the prologue and attempts to provide preliminary answers.

Chapter 3 is the heart of this thesis as it merges the theoretical framework of Naturalness Theory with the subject of grapholinguistics. Section 3.1 offers preliminary remarks as it discusses previous attempts at evaluating writing systems and assigns the proposed criteria to three categories (systematic/linguistic fit, processing fit, and sociocultural fit). It presents a transfer of ideas and concepts of Naturalness Theory to the domain of writing and formulates hypotheses that will be tested in the following sections. As the first subbranch of Natural Grapholinguistics, Natural Graphetics is outlined in Section 3.2. One after the other, the systematic, processing, and sociocultural fits of scripts are presented by considering the relevant external evidence and providing examples from a variety of scripts. Section 3.3 is dedicated to Natural Graphematics. The linguistic fit of the graphematic module is evaluated by investigating the different parameters of the semiotic structure of written signs. The processing fit is then discussed in relation to the linguistic fit, and the central question of how the linguistic fit affects the processing fit (and, though not as prominently, vice versa) is raised. A treatment of the sociocultural factors influencing the naturalness of the graphematic module closes the section. More briefly than the sections before, Section 3.4 provides rough ideas of what a Natural Orthography could be and how the concept of naturalness interacts with the specific procedures inherent in standardization that is superimposed upon the writing system by external agents. Finally, a comprehensive discussion (Section 3.5) puts all the findings of the chapter in perspective. It not only gives a critical summary but offers a context for the proposed Natural Grapholinguistics, emphasizes its relevance for the field and shows how the results can be implemented in applied settings such as education, type design, etc.

A conclusion at the end of the thesis will provide an overall summary and, on this basis, draw the most imminent conclusions. Additionally, an outlook will provide specific starting points for future research on the naturalness of and in writing.

With this thesis, I hope to contribute to a theory of writing, allowing linguists and interested researchers from other fields to learn more about the fundamental nature of writing as mediated by its users and the nature of these users – human nature. This, I believe, is valuable also for linguistics on a broader scale: it would be naïve to assume that in literate communities, writing does not exert an influence on speech, regarded as the primary subject of interest in linguistics. Writing affects the primarily spoken abstract language system on many of its levels, ranging from phonology to morphology, syntax, and pragmatics. Gaining a better understanding of how writing works and how this is connected to human nature possibly allows an integration into larger theoretical frameworks that are interested in language as a whole.

1 Naturalness Theory

In linguistics, few would challenge the view that *natural* is a somewhat problematic term. For opponents of *Naturalness Theory*, as well as for linguists largely unfamiliar with it,[1] *natural* is often (mis)interpreted as overladen with unscientific connotations that challenge its *raison d'être* as a linguistic term. *Natural* has indeed been widely used in precisely this vague pre-theoretical way: as a synonym of 'commonplace', 'expectable', 'normal'. This has contributed to a vicious circle in which *natural* never quite managed to divorce itself from its everyday language equivalent and the many meanings thereof (cf. Dressler 2000: 288; Dotter 2005: 48f). Proponents of Naturalness Theory such as Bailey (1984: 231) clearly criticize these uses, warning that "[i]t is naive and ill-informed to confuse the natural with the normal". In 2006, at a time when the heights of linguistic Naturalness Theory were a thing of the past, Martin Haspelmath claims (*en passant*, nonetheless) that "'[n]aturalness' is [...] another term [in addition to *markedness*, D.M.] that should be avoided by linguists" (Haspelmath 2006: 34). He thereby echoes the critics before him who have discounted *natural* and *naturalness* as terms unfit for the context of linguistics whose definitions should either be clarified or which should altogether be dispensed with.

Given this situation, a number of important questions arise: What *do* these terms actually denote and why did quite a number of prominent linguists – mainly between the late 1960s and the early 1990s – used them, and even decided to name linguistic approaches after them? In which way do these terms differ from their semantically neighboring and equally conflicted terms *marked/markedness*, *optimal/optimality* and *complex/complexity*? What is – despite all the opposition – the underlying reason for this apparent urge to resort to terms of this kind – *natural, (un)marked, optimal, simple, ideal* – all of which seem fundamentally related? These are some of the questions that will be addressed in this chapter. Its main goal is to thoroughly characterize Naturalness Theory in order to, in the next step, apply it to grapholinguistics.

In Section 1.1, I will investigate a number of the above-mentioned questions in order to provide a definition and operationalization of *naturalness* that will be used within the scope of this thesis. The question of how writing *per se* – in opposition to speech or even language – can be viewed as something *natural* will also be discussed. The following subsections will then focus on the various components of Naturalness Theory: Section 1.2 presents *Natural Phonology*, the first subbranch of the theory. Its key concept of natural processes will be introduced and central debates at the very heart of Naturalness Theory will be characterized. Section 1.3 is dedicated to the second subbranch, *Natural Morphology*, and describes how it provided a semiotic metatheory that constituted Naturalness Theory as a full-fledged theoretical framework. Concepts that are central for this thesis will be introduced: the subtheories of Naturalness Theory, the relevance of 'external' evidence, naturalness parameters, naturalness conflicts, and natural language change. In Section 1.4, I will then discuss other, less prominent subbranches of the theory, namely *Natural Syntax*, *Natural Textlinguistics*, and *Natural Pragmatics*. Section 1.5 provides a comparison between Naturalness Theory and the related theories of *Markedness Theory, Optimality Theory, research on linguistic complexity*, and *usage-based approaches to linguistics*. Finally, Section 1.6 closes the chapter with a summary.

[1] I have made this experience presenting an outline of this thesis at a conference on written language and writing systems (the 10th international workshop of the *Association of Written Language and Literacy* in Nijmegen in May 2016) when many of the participants – who were to a large extent unfamiliar with Naturalness Theory – reacted quite baffled by and skeptical of the use of *natural* within a linguistic context.

1.1 Definitions of *natural* and *naturalness*

Since one of the main points of criticism against Naturalness Theory concerns the use of the terms/concepts *natural* and *naturalness* and the alleged failure of the theory's proponents to provide precise and uncontroversial definitions for them (cf. Keller 1993; Raible 1988; De Cuypere & Willems 2008: 12), it is an absolute necessity to first outline what these terms denote and to define precisely their meanings within the scope of this thesis.[2]

Merriam-Webster offers a total of 15 meanings for the word *natural* as it occurs in everyday language.[3] Many of these can be quickly discarded in an attempt to arrive at an adequate definition of the technical term *natural* with reference to a linguistic theory of *naturalness* (cf. Dotter 1994: 144). I will argue, however, that some of these everyday meanings which are not part of the heterogeneous 'traditional' linguistic definitions of *natural* need to be reevaluated when Naturalness Theory is extended to the domain of writing. This is due to the fact that one of the most dominant meanings of *naturalness* is antonymous to *artificiality*, which was never an issue in 'traditional' Naturalness Theory. According to this meaning, writing is something inherently 'unnatural' in the sense of *artificial* – however, *artificial* does not equal *unnatural*. Using *natural* in association with writing requires careful separation of the many meanings *natural* can entail, and consequently, a reformulation of what can or cannot be *natural*.

As highlighted by the difference between *unnatural* and *artificial*, the respective antonyms of the different meanings of *natural* are instrumental to an understanding of its polysemy. Birnbacher (2014: 5f.) notes:

> The expression 'natural' and its linguistic cognates behave like semantic chameleons: they adapt their tones to the particular environment. Anytime there is talk of 'natural' it is about placing a contrasting element into view and distinguishing between what is natural and its specific opposite. The content of this opposite, the non-natural, can turn out to be very different depending on which contrary concept is intended: the supernatural, the unnatural, the cultural, the technical, the fake or the coerced.

A combination of some meanings of *natural* and their antonyms will allow drafting a comprehensive picture of *naturalness* that is capable of accounting not only for 'traditionally linguistic', but also for grapholinguistic problems. However, this picture is only preliminary, since the insights gained in the course of this thesis will serve as a backdrop against which the concept of *naturalness* will have to be reconsidered and possibly reformulated.

After deducing a preliminary general definition of *natural* from the above-mentioned colloquial uses of the word – which, granted, provocatively feeds into the criticism of it being a 'pre-theoretical' term – I will present some of the definitions formulated by prominent naturalists such as Charles-James N. Bailey, David Stampe, Wolfgang U. Dressler, Wolfgang U. Wurzel and others and compare them to the everyday meanings (for additional uses and meanings of the term *natural* throughout history, in linguistics, philosophy, and in general, that are not mentioned here, cf. Joseph 2007; Gardt 2008). The result is a definition of the linguistic term *natural* that serves as the basis of Naturalness Theory but that is *also* informed by colloquial uses – for if it were not, we could really just use a different, neutral term without all the connotations. Connotations that, however, are fitting.

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[2] Parts of this chapter have appeared in Meletis (2018).

[3] Cf. https://www.merriam-webster.com/dictionary/natural (March 15th, 2019). They are: (1) based on an inherent sense of right and wrong, (2) being in accordance with or determined by nature, (3) begotten as distinguished from adopted, (4) having an essential relation with someone or something, following from the nature of the one in question, (5) implanted or being as if implanted by nature, seemingly inborn, (6) of or relating to nature as an object of research, (7) having a specified character by nature, (8) occurring in conformity with the ordinary course of nature, not marvelous or supernatural, (9) possessing or exhibiting the higher qualities of human nature, (10) growing without human care, (11) being in a state of nature without spiritual enlightenment, (12) having a physical or real existence as contrasted with one that is spiritual, intellectual, or fictitious, (13) closely resembling an original, (14) having neither flats nor sharps, (15) of an off-white or beige color.

1.1.1 Natural$_{1a,b}$ vs. unnatural[4]

Natural as *humanly possible* vs. unnatural as *impossible*. One of the meanings that Merriam-Webster lists for *natural* is "being in accordance with or determined by nature/having or constituting a classification based on features existing in nature". Its antonym is *unnatural*.[5] This meaning must be fundamentally restricted in order to fit the theory. The central question that linguistic Naturalness Theory asks is: *What is natural in language*? Since language is a human phenomenon, the answer crucially depends on human 'equipment', human capacities, and their limitations (cf. Section 1.2.3). It is in this vein that we "use the expression 'natural' in order to separate that which is further away from the human being and that which is closer to him" (Birnbacher 2014: 3). Linguistic naturalness is concerned with what is natural not regarding nature in general, but more specifically regarding *human nature*.[6]

Human capacities, as well as their limitations, are determined by nature: the nature of our human bodies, minds, and our need for communication – our physiology, our cognitive skills, and the fact that we are social beings. In this sense, nature directly determines what can be considered *natural* in language: everything we can process with our bodies and minds is natural. While this everyday meaning of the word approaches the core of linguistic naturalness, it falls short of an exact definition, precisely because it would classify *anything* that can be produced and perceived within the boundaries of human capacities as natural. Consequently, all languages and language in general are natural. Consider the International Phonetic Alphabet (IPA) and the cells of the chart that are greyed out. These greyed out cells represent combinations of places of articulation and manners of articulation that are deemed to be physiologically impossible for humans to articulate. According to this broad reading of naturalness$_{1a}$, they are *unnatural* in that they are impossible, i.e. do not conform to human nature. Note that all of the sounds in the other cells are equal in that they are natural$_{1a}$, i.e. possible. This means that at this stage, there is no difference whatsoever between these sounds. In this reading, natural$_{1a}$ would, thus, be an exclusively descriptive notion (and not an informative one), rather than an evaluative notion.[7] The wrong assumption that this global meaning of *natural* is the definition advocated in Naturalness Theory is responsible for a considerable part of the criticism against the theory.

For example, Raible (1988: 114, my translation) asks "whether the languages that are declared as 'natural' are – in the sense of [...] Naturalness Theory – unnatural, or whether lin-

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4 The subscripts used here refer to the different readings of natural: *natural$_1$* has as its antonym *unnatural*, and *natural$_{1a}$* is the absolute reading, while *natural$_{1b}$* is the gradual reading. *Natural$_2$* has as its antonym *artificial*.

5 It is important to note that *not natural* is not synonymous with *unnatural*. *Not natural*, very neutrally, is simply the contradiction of *natural*. Everything between the polar opposites of the spectrum, i.e. *completely natural* vs. *completely unnatural* (see below), is logically both *not natural* and *not unnatural*. When something is *not natural* in the sense of Naturalness Theory, this does not mean that it is hard to process, but that it is not easy to process, and these two things are not necessarily the same. *Unnatural*, on the other hand, implies that something is hard to process for some reason.

6 Of course, one of the most dominant readings of the word *natural* concerns phenomena that "[exist] prior to and [are] independent of the human being" (Birnbacher 2014: 2) – they are, more generally, phenomena of nature, not of human nature. However, as this thesis is concerned with linguistic naturalness and the naturalness of writing in particular, we are only concerned with what is natural regarding human nature.

7 Some prominent naturalists such as David Stampe and Patricia Donegan reject the view of naturalness as an evaluative concept, at least within the domain of phonology, and hold that phonological naturalness is located at this global level of naturalness; this is in contradiction, however, with their different treatment of processes and rules, which both manifest themselves in human language, as well as with (implicit) statements that some sequences of sounds are changed by processes precisely *because* they are unnatural (cf. Section 1.2.3.2).

guistic Naturalness Theory is absurd".[8] This question fails to recognize two crucial aspects: first, in Naturalness Theory, it is not whole languages that are considered *natural* or *unnatural*, but individual features of languages. If applied to whole language systems, it is obvious that these systems must be *natural* in an absolute sense rather than *unnatural:* trivially, their mere existence proves they are in the realm of the humanly possible. This type of naturalness is what I refer to as *global naturalness*. This term emphasizes that there exists an *absolute* dichotomy between what is natural and what is unnatural: What is globally natural amounts to what is possible due to human physiology and cognitive as well as social skills, whereas what is unnatural is impossible. Furthermore, this type of absolute naturalness is inherent not only to language in general and whole language systems, but in turn also to *all* features of languages or specific phenomena found within these languages. If the definition were left at that, it would result in a situation in which phenomena are automatically deemed natural if they are in the realm of the humanly possible – whether they are attested in language(s) or not.[9] However, the definition of *naturalness* as it is advocated here does not stop at this point, for the second aspect mentioned above must be taken into account: *natural* can not only be interpreted absolutely, but also as a gradual concept (see below).

Natural as *innate* vs. unnatural as *not innate/learned*. Another meaning listed by Merriam-Webster is "implanted or being as if implanted by nature: seemingly inborn", which, famously, is what generativists believe applies to language (or at least a predisposition for it), proclaiming *Universal Grammar* and a *faculty of language*. This meaning of the word is also where the debate of *nature* vs. *nurture* is located. Naturalists do not concern themselves with the innateness of language as such, as it is not language that can be classified as innate within Naturalness Theory, but rather some of the relevant external constraints that shape its makeup, namely biology and cognition. As a consequence and similar to the first meaning provided above, language is *per se* considered as something natural, and everything occurring in it classified as *natural*. If this notion were to be accepted without further modifications, the application of a theory of linguistic naturalness would be grossly futile. It would also pose problems for a definition of *natural* that can be applied to the domain of writing, since writing is not innate, but learned.

Bailey (1974: 14, my emphasis), one of the first proponents of Naturalness Theory, encapsulates the problem with these first two meanings of *natural* when he states "[t]he naturalist [...] does not seek merely what works, but rather *what accords with man's linguistic faculties*. The naturalist is interested in formulations which are credible psychologically and physiologically". The subtle difference lies in the meanings of *work* vs. *accord with*, for not everything that merely works must also accord with 'man's linguistic facilities'.

More natural as *physiologically/cognitively/pragmatically easier to process* vs. less natural as *physiologically/cognitively/pragmatically harder to process*. Accordingly, the goal of Naturalness Theory is to arrive at a definition of *gradual naturalness* that allows the evaluation of linguistic phenomena in a given system as *more* or *less natural* with respect to pre- or extralinguistic faculties, bearing in mind that – as elaborated above – all of the elements

[8] „[...] ob die Sprachen, die als 'natürlich' bezeichnet werden, im Sinne der [...] Natürlichkeitstheorie unnatürlich sind, oder ob etwa die sprachwissenschaftliche Natürlichkeitstheorie absurd ist."

[9] This might seem like a puzzling side note at first, but it is relevant to realize that languages do not exploit the full potential of what is humanly possible. Thus, according to this meaning, phenomena are deemed *natural* if they are humanly possible regardless of whether they actually occur in languages or not. The crucial factor is that we can conceive of these hypothetical, non-existing phenomena, while we are not even capable of imagining phenomena that are outside of the realm of what we can process as humans. The greyed out cells in the IPA are possible counterexamples. They highlight which articulations are impossible to produce such as velar trills. Here, we have an image of 'velar trills' and can possibly imagine them as a category. However, in this case, this is facilitated as the IPA is a closed system that offers pre-existing categories (places of articulation and modes of articulation) that are combined to arrive at possible sounds. Without these categories, it would likely be impossible to just imagine the 'sounds humans cannot produce'.

and structures observable in language (and also those not observed, but imaginable) can ultimately be produced and perceived. Thus, it is adequate to talk about phenomena being *more* or *less natural* rather than being *natural* or *unnatural*. In this view, *natural* is not an absolute, but a gradual notion that signifies '(possible, but) more or less easy for humans to process'. In fact, the poles *completely natural* and *completely unnatural* are logically impossible or at least implausible configurations as far as language is concerned.[10] Nothing can be *completely natural* in this gradual sense since – as I will show – parameters of naturalness conflict with each other: if a linguistic phenomenon is natural with regard to one aspect, it is automatically less natural with regard to some other aspect.[11] Inversely, it is largely unlikely that a phenomenon is *completely unnatural* since that would mean that it is 'hardest to process physiologically/cognitively/pragmatically' in all imaginable respects. This strongly implies but does not entail that such a linguistically *completely unnatural* phenomenon should not occur in language – the gradual reading of *unnatural*, thus, only seemingly converges with the absolute reading.[12]

It is everything in between the absolute poles of *completely natural* and *completely unnatural* that is of interest to the naturalist, with all its subtle nuances and gradations. Since with regard to gradual naturalness, we are typically concerned with features of languages rather than with languages as a whole,[13] I call this type of naturalness *local naturalness*. *Local naturalness* will be the focus of this thesis,[14] and it is predominantly this type of naturalness that is treated in Naturalness Theory (and in related evaluative theories as well, cf. Section 1.5). To highlight the distinction between *global* and *local naturalness*, see also Birnbacher (2014: 5) who differentiates between naturalness as a classifying and naturalness as a comparative concept:

> 'naturalness' functions in the first sense [= global naturalness, D.M.] as a classifying concept; 'naturalness' in the latter sense [= local naturalness, D.M.] as a comparative concept. While the first pair of opposites classifies the phenomena such that all that exists fits neatly in one of the two categories, the second contrary is more akin to a mixture ratio. The question whether something is 'natural' can, as a rule, not be answered with yes or no, but instead with a more or less.

In this thesis, I am concerned with evaluating and comparing the naturalness of features of scripts and writing systems, not with classifying writing as natural (for that, see Section 1.1.2 below) or with evaluating the overall naturalness of writing systems. Thus, when I speak of

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[10] Cf. also Andersen (2008: 102, emphasis in original) regarding the logical impossibility of *unnatural*: "The terms *more natural* and *less natural* make it possible to avoid the logically contradictory terms *natural* and *unnatural*; unnatural cannot seriously be predicted of anything in a 'natural' language".

[11] It must be noted that on a single given parameter, for example *biuniqueness* (cf. Section 1.3.2), phenomena can, in fact, be completely natural. But this, then, exclusively concerns naturalness regarding that parameter and not an 'overall' naturalness, which cannot be achieved.

[12] It should be noted that in the literature, the ambiguous *unnatural* is often negligently used instead of the correct *less natural* (than Y with respect to parameter Z). The reason for this is that when stating that a phenomenon is *'not that natural'* without contrasting it with a different phenomenon that is *more natural*, thus talking about it in isolation, the absolute *unnatural* lends itself as a practical – but easily misinterpreted – label. Similarly, *natural* is an often-misunderstood term since it implies that something is completely natural, when in fact it only means that the phenomenon that is termed *natural* is *more natural* than a different phenomenon on a given parameter of naturalness (such as biuniqueness). In fact, there might exist another phenomenon that is even *more natural* on this given parameter, so the absolute use of *natural* in this context is misleading. Note that the choice of which end to use to interpret these terms, meaning whether to use *natural* (as done here) or *unnatural* as a reference point, is an arbitrary choice. Interestingly, Optimality Theory makes the same choice and uses *optimal* as a reference point, while *Markedness Theory* and approaches within linguistic complexity research use *marked* and *complex*, and, thus, the other end of the spectrum (cf. Section 1.5).

[13] Of course, logically, amassing the local naturalness values of *all* the features of languages and adding them up seemingly amounts to an evaluation of the naturalness of entire language systems. Still, local naturalness is vital and primary, since the naturalness of a whole language cannot be evaluated without a former evaluation of the naturalness of its parts.

[14] This means that no statements of the type 'Writing system X is more natural than writing system Y' will be made. Instead, the focus is on statements of the type 'Feature Z of writing systems is more natural in writing system X than it is in writing system Y'.

naturalness, I generally mean *local naturalness*; if *global naturalness* is intended instead, I refer to it explicitly.

To sum up: linguistic phenomena must be natural in the absolute meaning of the word in order to be humanly possible, and with regard to gradual naturalness, they must exhibit naturalness in some respects in order for humans to be capable of (easily) processing them. As ideal language users (for a discussion of this term, cf. Saniei 2011), we should hypothetically be capable of pronouncing/writing (or hearing/reading) all the units of a given language or writing system. The reality, however, is drastically different: many of us are not able to orally – let alone in written form – produce every element of a language. This is due to several reasons, one of which is the differing degrees of naturalness. Simply because humans can use a broad variety of different linguistic elements does not mean that the processes involved are equally 'easy'. The key part of a definition of linguistic naturalness is, thus, a criterion that can be used to evaluate what can be deemed natural and where phenomena fall on the scale of naturalness.

In this context, words like 'ease' or 'effort' are not uncommonly used as labels for such a criterion. These terms are meant to convey that linguistic elements that are *easier* to process (i.e. require less *effort* to be processed than others) are more natural than elements that strain human capacities to a larger degree. Accordingly, Dressler (2000: 288) specifies that *natural* is "often synonymous to cognitively simple or easily accessible", while Mayerthaler concludes that the meaning of "more or less natural […] really boils down to '*more or less easy for the human brain*'" (Mayerthaler 1987: 27, emphasis in original). In these quotes, the focus is on *cognition*; however, *physiology* – e.g. what is more or less easy for the articulators and receptors, mouths/hands and ears/eyes – and *social factors* – e.g. what is most natural for the purposes of communication – are of equal importance. From this follows that what is *more natural/less natural* cannot be evaluated (exclusively)[15] language-internally but requires the consideration of language-external evidence; it can also not be evaluated in isolation, but only in comparison: nothing inherent in a single linguistic element can tell us whether it is more or less natural than some other given element. This reveals that Naturalness Theory is a theory that relies heavily on the study of what is referred to as 'linguistic *performance*' (cf. Dziubalska-Kołaczyk 2002a: 104), since the cognitive/physiological/social naturalness of linguistic phenomena, i.e. the ease with which they are produced and perceived, can only possibly be determined when we take into account their *use*.

An interim definition of linguistic naturalness that has already been advocated by Naturalness Theory reads as follows: *naturalness* refers to the effort involved in using language – this includes production as well as perception – with respect to external constraints. On the one hand, these external constraints are the physical and cognitive makeup of the human body, specifically the parts that are relevant for the use of language. On the other hand, psychosocial considerations of humans as socio-communicative beings are also crucial aspects of the notion of linguistic naturalness. Bailey (1984: 229) accordingly speaks of "a balance between (bioneurolinguistic) structures and (sociopragmatic) communicational functions". This perfectly corresponds with Dressler's (1980: 75, emphasis by me) understanding of naturalness: "Naturalness must be derived from considerations of the *nature of man*, who is not only a speaker-listener, but also a non-verbally communicating being conditioned by biological, psychological and social properties. Therefore[,] any 'natural linguistics' must be based on such extralinguistic considerations […]". Crucially, Wurzel (1994a: 2592) adds to the biological and social factors the factor of culture-specificity that plays a pivotal role in the analysis of writing.

This definition of naturalness has at times – in this case by an adamant critic – been labeled a "physicalist (or even perceptual or cognitive) definition of naturalness" (Lass 1980b: 97). What constitutes the so-called 'physicalist' evidence used to uncover and operationalize what is intended by "effort" will be investigated in detail in Sections 1.2 and 1.3 in which the major sub-

[15] We will see that for some types of naturalness, mainly on the level of system-dependent naturalness (cf. Section 1.3.2), language-internal evidence is also relevant.

branches of Naturalness Theory, Natural Phonology as well as Natural Morphology, are characterized.

With this working definition of *naturalness*, I will attempt to apply the concept to the domain of writing, which was not treated by traditional Naturalness Theory (and, as I will show later, was to a large degree ignored by linguistics in general). One of the main questions of this thesis reads as follows: Can a definition of linguistic *naturalness* be transferred to grapholinguistics and if so: what are the gains of this endeavor? Has the notion of *naturalness* – or related notions – been addressed in the study of writing systems – and if so, how? However, before these questions can be answered, we need to look at another reading of *natural* that is strongly associated with writing: *natural* as opposed to *artificial*.

1.1.2 Natural$_2$ vs. artificial

A crucial paradox that needs to be addressed in a thesis on the naturalness$_1$ of writing is the fact that writing is often in general discounted as *unnatural*. This view manifests itself quite ostentatiously when writing is juxtaposed with speech: the latter is usually interpreted as primary, both phylogenetically and ontogenetically (cf. Dürscheid 2016: 30; cf. also Waugh 1982: 308f.[16] and Section 2.1). One of Merriam-Webster's definitions of *natural*, "seemingly inborn", does not apply to writing, for writing is not "implanted" by nature. Unlike speech, writing requires explicit instruction, and quite notably, unlike speech, it is not acquired by everyone, considering cultures without literacy or illiterate people in literate cultures. To some extent, if compared to speech, writing is not *natural*. However, since we can and *do* master it anyway, writing – as a cultural technique – cannot be *unnatural* in the sense of global naturalness. The intuition that writing is unnatural stems in large part from the antonym of a different reading of natural$_2$ that characterizes writing: it is *artificial*, it is an artifact (cf. Treiman & Kessler 2014: 104). This echoes the meaning of *natural* Merriam-Webster gives as "existing in or produced by nature/not artificial". Also, crucially, it is where the debate *nature* vs. *culture* is negotiated.

A conceptually useful tool that helps to understand how something can be both natural$_1$ and artificial at the same time is Rudi Keller's characterization of phenomena of "the third kind". Keller posits that the dichotomy *natural$_2$ phenomena* vs. *man-made artefacts* is insufficient since there are two subtypes of man-made phenomena.[17] What obscures this fact and makes it difficult to grasp is the lack of a fitting linguistic attribute for one of the two subtypes of these man-made phenomena: these are what Keller calls *phenomena of the third kind*. As Keller (2014: 88) notes, we do in fact distinguish between the two man-made types conceptually, but not terminologically: examples that he juxtaposes in order to illustrate the two types are "natural forms of payment (money) and artificial forms of payment (substitutes for money), […] a town that has grown naturally and an artificial town (planned on the drawingboard), […] a natural alphabet and an artificial one, and […] natural and artificial languages" (Keller 1994: 59). Clearly, money, naturally grown towns, and 'natural' alphabets (as well as, arguably, natural languages, see below) do have something in common: they are, compared to, e.g., natural flowers, not *directly* natural in the sense that they are phenomena of nature, or, as Birnbacher

[16] In terms of markedness (cf. Section 1.5), a concept closely related to naturalness, Waugh (1982: 308f., emphasis in original) notes that "when using the term language, linguists use it either in the zero-interpretation, meaning 'language in whatever form it has', or in the minus-interpretation, meaning 'spoken language', since the mark is carried by *written language*". This is why often, *language* is conflated with its minus-interpretation, namely *speech*. This, in turn, is also the reason why a representational view of writing that holds "writing represents language" is often vehemently rejected. "Writing represents language" does, however, in light of the facts, not mean that writing represents only speech, but language in general, and this follows logically from the narrow definition of writing which holds that it is the visual *representation* of language. This is discussed in more detail in Section 2.1.

[17] Cf. also Birnbacher (2014: 3): "[…] the polarity of what has become and what has been made, which is the basis for our orientation in the world, is only valid proximately, not absolutely".

(2014: 3) puts it, "what has become". However, what distinguishes these phenomena from their counterparts (substitutes of money; planned, artificial towns; etc.) is that they have "grown organically" (Keller 1994: 59), where "organically" is another term that invokes an association with nature and living beings. These organically grown phenomena are phenomena of the third kind; they "resemble natural phenomena in that they are unintended and to be explained in terms of efficient causes, and they resemble artificial phenomena in that they are the result of human action" (Haakonssen 1981: 24). Ultimately, they mix the natural with the artificial and can be considered a hybrid form in between. As Birnbacher (2014: 4) remarks on this matter, "[t]he 'flawlessly' natural and the 'flawlessly' artificial are more like imaginary poles which actually belong to a spectrum where we only know the intermediary domain". Writing, as a phenomenon of the third kind, is located in this intermediary domain. It is artificial – but it is *naturally*$_{1b}$ artificial.

This reading of natural is also the one intended in the term *natural*$_2$ *language*,[18] the opposite of which is *artificial* or *constructed language* (cf. Bartlett 2006). A *natural*$_2$ *language* is a language that was not *invented* by humans but rather developed organically as opposed to an *artificial* or *constructed language* that is evidently man-made. Take for example German, which is an Indo-European natural$_2$ language that originated from an assumed common language referred to as Proto-Indo-European that has yielded hundreds of other languages of the world that are still spoken. Esperanto, by contrast, is a constructed language intended for 'real-life' use (though it is seldom used), while Elvish languages (e.g. those invented by J. R. R. Tolkien) or Klingon are constructed languages specifically made for fictional works of art. Two important factors that distinguish natural$_2$ from artificial languages are (1) (wide-spread) *use* and (2) *time*. Natural$_2$ languages are widely used, in all contexts, while artificial languages are usually highly restricted in their use. Also, natural$_2$ languages have a long history, while artificial languages, by comparison, are – no matter how far back in the past they might have been constructed – remarkably young. However, these two factors are precisely what makes the dichotomy natural$_2$ vs. artificial gradual rather than absolute: in theory, an artificial language could, if it is widely used over a long period of time, become more 'natural' in that it assimilates to what natural$_{1b,2}$ languages resemble. During this time, the artificial language in question is shaped by being used, specifically by its users and their features and needs. Now replace artificial language with writing. Writing was invented roughly 5,000 years ago, which makes it a fairly recent invention, especially when compared to speech. However, 5,000 years is still a long time, and writing has undergone a lot of developments since its invention(s).[19] It is my goal to investigate *how* it was shaped and *what* the exact (human) pressure was that led to its reshaping. Obviously, I believe Naturalness Theory is a fitting tool for this enterprise.

The different meanings of *natural* as underlined by their different antonyms (and subscripts) are not mutually exclusive: *everything* that humans process linguistically has to be absolutely *natural*$_{1a}$ as opposed to *unnatural*. On a different level, this means that not only *natural*$_2$ languages, but also *artificial/constructed/man-made* languages must be natural$_{1a}$ in the first sense. Put simply: this thesis acknowledges that writing *per se* is artificial; this, however, does not prevent us from investigating, in the sense of *gradual* (and, crucially, *local*) *naturalness*, what the more natural$_{1b}$ features are *in* something artificial such as scripts and writing systems.[20]

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[18] From the perspective of the absolute reading of natural$_1$, the term *natural language* seems strange, since all language – even artificial ones that are not natural$_2$ – must be natural$_1$ in the absolute sense.

[19] As I will mention in Section 2.2, the current consensus is that writing was invented independently more than once.

[20] The shift from global and absolute naturalness to local and gradual naturalness is reflected in the slight change that the title of this thesis underwent: originally, it was *Naturalness <u>of</u> scripts and writing systems* before I changed it to the more fitting *Naturalness <u>in</u> scripts and writing systems.*

Birnbacher's account of naturalness offers an additional distinction of these two different readings of naturalness which is useful to illuminate that it is not paradox that writing is both *natural* and *artificial* at the same time:

> I would like to suggest differentiating between a *genetic* and a *qualitative* naturalness, or artificiality. In the *genetic* sense 'natural' and 'artificial' express something about how something originated, in the *qualitative* sense they express something about its actual *constitution* and *appearance*. 'Natural' in the genetic sense is what has a natural origin, 'natural' in the qualitative sense is what does not differ from that which is to be found in nature. [...] Taken in their genetic sense, naturalness and artificiality are *historical* terms; they are related to the past. [...] In a qualitative sense naturalness and artificiality are *phenomenological* forms of description; they relate to the way something actually appears and are related to the present. (Birnbacher 2014: 7, emphasis in original)

Writing is artificial in a genetic, historical sense, but at the same time, in some respects, it is natural in a qualitative, synchronic sense. The latter explains how, at first glance paradoxically, "[w]hat is cultural, technological and artificial also appears as pure nature" (Birnbacher 2014: 3). Note that here, talk is still of naturalness$_2$ as the opposite of artificiality, not naturalness$_{1a,b}$ in the sense elaborated above. Writing can display naturalness in a qualitative sense if it is, for example, pictographic. In this case, writing imitates natural (but not only natural!) objects by means of visual similarity. This corresponds with one of Merriam-Webster's meanings for *natural*, "having a form or appearance found in nature". It is expected in Naturalness Theory that qualitative naturalness has a connection to naturalness in the 'physicalist', that is physiological/cognitive/social sense, but it is paramount to carefully distinguish these two types of naturalness.

While the category invoked by Birnbacher's term *qualitative sense* seems to parallel exactly Keller's distinction of the two types of man-made phenomena, their categorizations differ in a crucial way. As Birnbacher's use of *phenomenological* with respect to *qualitative naturalness* implies, this is a descriptive category. It aims to describe how a phenomenon that is genetically artificial can exhibit, synchronically and phenomenologically, natural features. Keller's concept of phenomena of the third kind, in contrast, explicitly includes a historical dimension. This is highlighted by the fact that they are defined as phenomena that have "grown organically", with the verb *grow* insinuating a process. What is interesting, now, is a combination of Keller's and Birnbacher's concepts which yields, among others, the following questions: what is the relationship between the phenomenologically natural features of phenomena of the third kind and the way these phenomena have "grown organically" over the course of time? And how is this question related to human nature? In other words: what does "grow organically" even mean and how does the fact that something "grows organically" influence the synchronic structure of a system? These questions aim at an explanation rather than a mere description.

To sum up, writing is natural$_{1a}$ in an absolute way in that it is in the realm of the humanly possible. In this sense, everything that occurs in writing can be *classified* as natural$_{1a}$. In a genetic, that is, historical sense, writing is artificial since it was made by man. However, most writing has grown organically and was not made "inorganically".[21] At the lowest, local level, naturalness$_{1b}$ is a comparative and scalar concept. The present study is located at precisely this

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[21] It must be noted that not all writing is seen as a phenomenon of the third kind that has "grown organically". A crucial (gradual) distinction is made between ancient grammatogenies and modern grammatogenies (cf. Daniels 2013: 56). Ancient grammatogenies are the first times writing was (independently) invented – this applies to Sumerian, Chinese, and Mayan writing. Subsequently, all other types of 'invention' of writing were profoundly informed by the fact that writing already existed. It can be argued that some writing systems that resulted from modern grammatogenies, which occurred rather recently, such as the creation of the writing system of Cherokee, are not phenomena of the third kind as not enough time has passed since their invention for them to have "grown organically". While genetically, writing systems that resulted from ancient vs. modern grammatogenies are similar in crucial ways, it seems that the temporal aspect, meaning their relatively recent development, keeps the latter from arriving at the consequences/benefits (?) of what it means to have "grown organically". These include, quite possibly, being phenomenologically and cognitively/physiologically/socially more natural.

level. Figure 1 illustrates how the different dimensions of naturalness are hierarchically organized. The focus of the present thesis is highlighted by the grey circle.

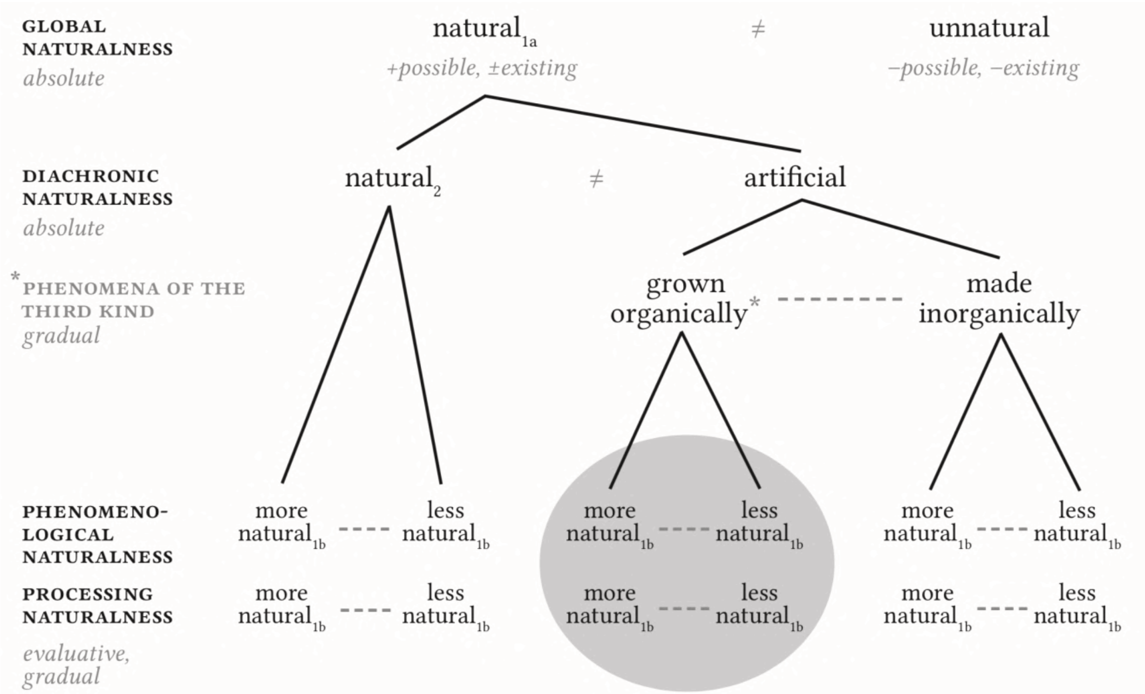

Figure 1: Dimensions of naturalness

Here, we are interested in two tasks: (1) identifying what is qualitatively, phenomenologically natural in writing, which answers the question: how do features of writing resemble features found in natural phenomena? And secondly, we need to (2) compare what is relatively more $natural_{1b}$ than what is relatively less $natural_{1b}$ in writing with regard to specific parameters that are based in physiology, cognition, and socio-communicative factors. Finally, what we may investigate is that these two types of comparative naturalness – phenomenological and processing naturalness – might correlate in crucial ways.

1.2 Natural Phonology (NP)

> [I]n general the conditions of the *use* of language [...] are responsible for the *nature* of language. (Stampe 1979: 43, emphasis in original)

In the late 1960s, the notion of *naturalness* gained importance in linguistics with the advent of so-called *Natural Phonology* (NP). This was the first subbranch of what was later subsumed under the heading of Naturalness Theory. It was helmed by David Stampe – his PhD dissertation, originally titled *How I spent my summer vacation* (1972, University of Chicago), and later published as *A dissertation on Natural Phonology* (1979), can be considered the official birth of the theory (at least in print[22]). NP was then further developed by Stampe and other naturalists, among them Patricia J. Donegan, who shaped it with important contributions (such as Donegan 1978/1985a). Some historiographic accounts additionally mention Charles-James N. Bailey as a co-founder of the approach – focusing on variation and language change and not phonology, however – and an early naturalist (cf. Wurzel 1988: 99; Elsen 2014: 174). Even though there exists an extensive body of research within the paradigm of NP (cf. Luschützky's 1991 bibliography), overviews of the main positions of the theory are sparse. These few accounts include Donegan & Stampe (1979) and Donegan & Stampe (2009), with significant modifications (see below) also Dressler (1984), and, from the perspective of application in communication disorders, Edwards & Shriberg (1983). These works should be consulted for a more extensive descriptive picture of NP, as this present section aims to selectively highlight mainly those core historical circumstances and theoretical ideas that are expected to be relevant and fruitful for the proposed Natural Grapholinguistics. As such, it should be considered one of the first[23] critical readings of NP based on fundamental statements (often consciously represented as undistorted direct quotes) that core phonological naturalists have made.

Historically, and in terms of theoretical ideas, NP represents the "modern development of the oldest explanatory theory of phonology" (Donegan & Stampe 1979: 126). It is a direct response to the fact that "during the twentieth century, the rich fabric of explanation and evidence traditional phonology had woven of causality, intention, and consciousness, was dismissed as a tissue of unscientific reasoning" (Stampe 1985: 133). NP embodies a continuation of precisely these 'traditionally phonological' ideas that had emerged in the 19th and 20th centuries.[24] Incentives that were especially central for Stampe's motivation to establish NP were his observations that there exist cross-linguistic patterns in children's acquisition of phonology and that children's phonology is more complex than adults' (cf. Hurch 1988: 7). These considerations led Stampe to take up Sapir's (1933) phoneme theory, resulting in a mental(istic), psychologically defined phoneme concept that stands in sharp contrast to the structuralist and generativist conceptions of the phoneme. Although it must be mentioned that the phoneme is not a particularly central concept in NP – this role is served by the phonological processes, cf. Section 1.2.2. While structuralists reduced the phoneme to its distinctive function – its opposition with other phonemes – generativists, particularly Chomsky and Halle, did not accept this 'discovery procedure' as a definition of the phoneme, and, because of Halle's phonological

22 Bjarkman mentions papers on NP given to the Chicago Linguistic Society, with those given before 1968 mostly unpublished and some given after 1969 published. This emphasizes that NP had existed for some time prior to Stampe's dissertation. However, it was undoubtedly his dissertation that, for the first time, represented "a much fuller text from which to assess the claims of natural phonology" (Bjarkman 1975: 60).

23 NP seemingly never spread wide enough for there to be elaborate reviews or encyclopedia articles that go beyond the presentation of core principles. Overview chapters within larger works – such as the first chapter in Hurch (1988) – remain exceptions.

24 Specifically, Donegan & Stampe (1979: 126) state that the elements that NP is integrating "evolved in nineteenth-century studies of phonetics and phonetic change (Sweet, Sievers), dialect variation (Winteler), child speech (Passy, Jespersen), and synchronic alternation (Kruszewski, Baudoin), and developed further, still without integration, in twentieth-century studies on dynamic phonetics (Grammont, Fouché) and phonological perception (Sapir, Jakobson)".

analysis of Russian, rejected the phoneme altogether[25] (cf. Stampe 1985: 133; Nathan 2007: 93; for other differences between NP and generative phonology, see Section 1.2.4). Naturalists, too, considered the 'objective' structuralist definition to be reductionist,[26] but they did not opt out of the phoneme altogether.

1.2.1 Phonemes

In NP, phonemes are mental intentions of pronounceable speech segments – they are "sound intentions" (Dressler 1984: 32; Balas 2009: 47). In adhering to this definition, NP directly takes up notions such as 'Lautabsicht' and 'Lautidee' which were pondered by early phonologists (cf. Baudouin de Courtenay 1895). This leads Nathan (2007: 93) to characterize phonemes in NP as the "Baudouin/Sapir/Stampe-Donegan view of fully specified acoustic/articulatory idealized targets", underlining the heritage of phonological theory continued by NP (cf. also Hurch 1988: 25). A central term that Nathan chooses that helps to understand the phoneme concept in NP is *target*: phonemes are mental sound images that speakers *intend* to articulate, while what they actually produce in speech are targets, the materialized output(s) of phonological processes. The initial mental intentions, thus, can be conceptualized as idealized targets in that they do not need to (and often do not) correspond with the actually produced targets (cf. Figure 2). While the idealized mental sound intentions represent the level of *phonological representation*, the phonetic output represents the level of *phonetic representation* (cf. Moosmüller 2007; Donegan & Stampe 2009: 20).

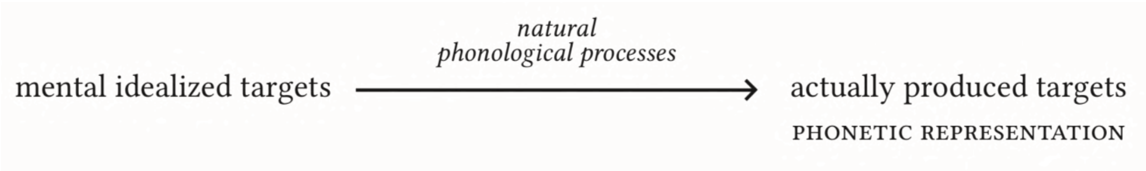

Figure 2: Idealized vs. produced targets

Thus, Stampe (1985: 136, underlining in original) explains how to arrive at a phonological (in his terms phonemic) representation:

> The phonemic representation of any utterance is that which results from applying to its phonetic representation, in reverse, the minimal number of substitutions necessary to obtain a representation entirely in terms of phonemes.

The substitutions that intervene between phonetic and phonological representations are natural phonological processes, on which NP's phoneme conception is dependent (cf. Wojcik 1976: 54) and which will be discussed in detail in the following section.

The nature of phonemes as sound intentions reveals itself in perception: as speakers, when speaking, what we hear is not what we say, but what we intend(ed) to say (cf. Donegan &

[25] This is based on Halle's (1959) finding that if one assumes three levels of representation, a (1) morphophonemic level, a (2) phonemic level, and a (3) phonetic level, the process of regressive voicing assimilation in Russian must occur separately (and thus, twice) on two of these levels: an assimilation of /k/ to /g/ is morphophonemic, because both /k/ and /g/ are phonemes of Russian – thus, one phoneme changes into another. However, phonemes whose voiced/voiceless counterparts are *not* phonemes of Russian also take part in this assimilation, whereby the phoneme /ʧ/ becomes [ʤ], which is itself not a phoneme, but an allophone. Thus, this latter assimilation is not a morphophonemic, but a phonemic process. Because the same process would have to apply twice on different levels, Halle rejected the phonemic level and the notion of phoneme (cf. Dresher 2011: 257f.; Schane 1971: 517-519).

[26] Cf. Donegan & Stampe's (1979: 129) reckoning with the distinctiveness criterion: "But words are not only distinguished by sounds, they are made up of them. It is no less important that the sounds that constitute words be distinguishable than that they be pronounceable, combinable, and perceivable (articulate, audible)".

Stampe 1979: 159). This applies also when listening to the speech of others: we perceive not what the speakers are actually saying, but what they meant.[27] Thus, the phoneme in NP is "an underlying intention [...] *shared by the speaker and listener* (who are always 'two in one')" (cf. Dziubalska-Kołaczyk 2007: 72, my emphasis). An idea closely related to these observations that we will reencounter and that will be critically reflected in the discussion of writing is the primacy of perception, which Dressler (1984: 33) stresses for speech:

> If phonemes are defined as phonological intentions, and if phonology serves communication, and if the most important goal in communication is to be understood, then phonemes must primarily serve optimal perception rather than ease of articulation.

1.2.2 Natural phonological processes

1.2.2.1 Processes vs. rules

The most central tenet of NP is the assumption, description, and explanation of so-called *phonological processes*. These are contrasted with *morphonological rules*. The former are deemed *natural*, while the latter are not considered natural.

An example of a natural process is the devoicing of final obstruents, as in German *Hund* 'dog', the phonological representation of which is (in NP) /hʊnt/ – here, the feature [+voiced] is substituted by the feature [−voiced] in the final obstruent because voiced obstruents are 'more difficult' to produce (cf. Hurch & Nathan 1996: 235). An example of a morphonological rule, on the other hand, is umlauting as in German SG *Mann* /man/ 'man', PL *Männer* /ˈmɛnɐ/ 'men'.

There exists no exhaustive list of natural processes (cf. Ball, Müller & Rutter 2009: 134). Main efforts to devise such lists – including chronologies of processes, detailing the sequence in which processes usually occur and/or are inhibited – have been made in the context of clinical phonology (for an overview of lists of processes, see Grunwell 1997: 47-62).

NP's main claim is that natural phonological processes, as sound substitutions, are reactions to difficulties in the articulation and perception of speech. They are, in classical Stampean NP, generally understood to be 'innate' (but see Section 1.2.2.2 for a clarification). In L1 acquisition, children must inhibit certain processes that are not active in the phonological system of the language. A child acquiring English, for example, must inhibit the above-mentioned natural phonological process of final obstruent devoicing, because, in English, final voiced obstruents do occur. The phonology of a given language is thus shaped by which processes are inhibited and which remain active. The following, non-exhaustive list[28] gives an overview of the most important characteristics of processes (and, if explicitly mentioned in the literature, rules[29]):

— Processes are "categorical mental substitutions" (Donegan & Stampe 2009: 1f.; cf. also Donegan & Stampe 1979: 126). They are motivated by "mental constraints on speech performance" (Wojcik 1976: 47). This means – as will be discussed in detail below – that

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[27] "In our normal and effortless perception of utterances, we perceive not the actual sounds, nor the words or sentences that are said to us, or even their literal meanings, but what the speaker meant" (Donegan & Stampe 2009: 26).

[28] Although in this list, a number of different scholars are cited, it is paramount to note that most of what is described here has first been proposed by Stampe (1979) himself in the initial outline of NP.

[29] Singh (1996a: 11) observes that while processes, as the core of NP, are treated extensively within the approach, not much is said about rules or why they are claimed to not be natural, stating "it is not clear precisely what Natural Phono(morpho)logical 'rules' are 'rules' of", and he goes as far as even questioning what *morphonology* is. Numerous contributions on the topic of morphonology are collected in Singh's (1996c) edited volume *Trubetzkoy's Orphan*. In the same vein, Bjarkman (1975: 60), at a time when the fleshing out of the theory was still in progress, claimed that what was "particularly unsettled [...] is Stampe's division between rules and natural processes". This situation did not change noticeably, as focus remained on the processes while rules were never given an extensive treatment.

while processes are physical reactions to phonetic constraints, they are fundamentally mental (cf. Donegan 1985a: 3). In this context, Rhodes (1973: 536) also mentions that the psychological status of processes differs from the status of rules. Bjarkman (1975: 71, underlining in original) brings up the interesting point that the "mentalistic motivation which is based on physiological motivation" influences only "what speakers believe are restrictions on pronounceability", not the actual restrictions. He offers the example of English speakers who consider [pt] to be an unpronounceable cluster but who, nevertheless, in rapid speech, utter strings like [pˈteɪtə] 'potato'.

— Processes are unconscious and can become conscious only negatively, "by confrontation with pronunciations which do not conform to the process, as in L2 acquisition" (Donegan & Stampe 1979: 144), e.g. when L1 speakers of German learn English and are required to produce voiced final obstruents. It must be noted that not only processes but also rules can be "habitual and quite unconscious" (Donegan & Stampe 2009: 9).

— Processes are, as already mentioned, innate (cf. Donegan & Stampe 2009: 6; cf. Section 1.2.2.2 for a discussion).

— Processes are phonetically motivated, while rules represent morphophonemic alternations (Hurch 2006: 541). Rules are "alternations of phonemes particular to certain morphosyntactic situations" (Donegan & Stampe 2009: 5), which leads to the next feature of processes:

— Processes, because they are conditioned phonetically, are automatic in that they, in principle, always (with some exceptions, see below) apply as long as a specific phonetic context is met – such as when obstruents occur in syllable-final position. Rules, in contrast, are not automatic, as their application is motivated not phonetically, but lexically or grammatically (cf. Hurch 2006: 541; Hurch 1988: 8-9). Processes, thus, have a phonetic motivation, whereas rules do not need to have such a motivation, but certainly *can* have it (cf. Donegan & Stampe 1979: 144): the latter is especially the case when processes have developed into rules diachronically. In these cases, phonetic motivations might still be transparent in rules.[30]

— The application of a process changes a single phonetic property in order to overcome a phonetic difficulty. Phonologically, processes "change one feature" (Donegan & Stampe 1979: 137), such as [+voiced] to [−voiced] in final obstruents.

— In a way, processes can be seen as functioning *bottom-up*, as speakers' limitations shape the phonological system of a language. Processes are thus "restrictions the speaker imposes on his language". For rules, the opposite is true: they are *top-down* and represent restrictions "the language imposes on the speakers" (Hurch 2006: 541).

— Processes are universal.[31] However, they do not (have to) apply universally (cf. Donegan & Stampe 2009: 6-8). Since, if there are no speech impediments, humans are usually born with the same articulatory and perceptual apparatus,[32] processes are universal, which al-

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[30] In this context, the two concepts of *transparency* and *opacity* are worth mentioning, which have been established by Paul Kiparsky (cf., for example, Kiparsky 1982: Chapter 4). They are relevant, for example, in historical phonology, as Kiparsky (1982: 78) claims that the opacity of rules is one factor that contributes to their loss in the course of historical change. A rule A → B / C __ D is opaque if there are surface representations of A in the context C __ D or of B in contexts other than C __ D (cf. Kiparsky 1982: 75).

[31] Dressler (1984: 30) distinguishes between *process types* and *processes*. For him, *process types* (such as syllable-final devoicing) are universal, while *processes* "are those language-specific phonological processes which are derived from them", such as final obstruent devoicing specifically in German.

[32] Wojcik (1976: 47) raises the question of whether processes "differ in people with speech tracts of widely different proportions", a question that, to my knowledge, has not been answered. In my reading of NP, there is an idealized speech (and auditory) tract that accounts for the processes. If a person's anat-

so correlates with them being 'innate'. And yet, *how* certain phonetic challenges are overcome is language-specific, which is why in some languages, a given process remains active while in others, it is inhibited. As Donegan & Stampe (2009: 6) put it, processes are "natural responses to [...] limitations that can be overcome by learning a language, if the language requires it, but which otherwise remain as the true phonology of the language".

— Processes are productive, rules are not (Hurch 1988: 9; Dressler 1984: 38). As expected, thus, processes apply in speech errors and tongue-slips, in foreign words, etc. (cf. Donegan & Stampe 1979: 144). They also lead to negative language transfer, when a process of an L1 is applied in the context of an L2 in which it is inhibited (or vice versa). Speakers of German (to beat this example to death) must suppress final obstruent devoicing when learning English, and failing to do so leads to mistakes in pronunciation. Rules, on the other hand, are not transferred from L1 to L2 (cf. Donegan & Stampe 2009: 12).
— One possible cause for this negative transfer in L2 acquisition is that violating a process "requires special motivation" (Donegan & Stampe 2009: 5), and not only special motivation, but also "special attention and effort" on behalf of the speaker. Voicing final obstruents in an L2 when in the speaker's L1, they are devoiced, does not come 'naturally', it is associated with effort. The violation of rules, by comparison, does not require special effort (cf. Hurch 1988: 10).
— Even though they are productive, processes cannot be "borrowed" from one language by another (cf. Donegan & Stampe 1979: 144). Either a process is already active in the phonological systems of two languages or it is active in one and inhibited in the other (or it is inhibited in both).
— Processes are variable in their application; they are, in this sense, optional (cf. Bjarkman 1975: 67), whereas rules are not. Because processes apply "in real time" (Donegan & Stampe 2009: 10), their application is sensitive to factors such as tempo or other external conditions (Donegan & Stampe name fatigue, drunkenness, objects in the mouth, injuries, but also lack of attention or care, situations of high redundancy, very frequent words, etc.). This also means that processes that are inactive in a language can still apply when one of the above-mentioned factors intervenes (cf. Donegan & Stampe 2009: 1). Also, this explains why processes are not applied universally even though they are universal.
— For each process, there is an opposing process "with exactly opposite effects" (Donegan & Stampe 1979: 143); for insertion, there is also deletion, for syllabification, there is desyllabification, for dissimilation, there is assimilation, and each pair of opposing processes applies in identical contexts. After nasals and before spirants, for example, a plosive that is homorganic to the nasal and of the same voicing as the spirant can be inserted or deleted: in the first case, the result is [sɛn(t)s] *sense*, while in the second case, it is [sɛn(t)s] *cents* (cf. Donegan & Stampe 1979: 143).

Before I turn to the two central types of processes below, let me mention two relevant distinctions, the first of which is *manifest* vs. *latent processes*. Manifest processes are active in a given language and shape its phonology. Latent processes, on the other hand, are neither active nor inactive in a given language, simply because the context in which they would apply is not present in the language (cf. Hurch 1988: 17; Dressler 1996a: 41). Take, once again, final devoicing: languages such as Vietnamese, Chinese, and Japanese lack final obstruents. Because of the lack of the necessary context, the process is latent in these languages. Now, when native speakers of these languages acquire an L2 *with* final obstruents, the process becomes manifest and active – even if in the L2, it is inhibited. This is the case with Japanese speakers learning English: they automatically devoice final obstruents because in the acquisition of Japanese, they did not have to inhibit this universal process (cf. Schmid 1997: 338; Balas 2009: 49). The second distinction is

omy differs from this idealized anatomy and this leads to a differing application of processes, this would probably already be treated as a speech disorder.

paradigmatic vs. *syntagmatic processes*. While paradigmatic processes optimize individual segments, syntagmatic processes optimize sequences (cf. Donegan & Stampe 2009: 6). Paradigmatic processes can be context-free or context-sensitive and are always fortitive, while syntagmatic processes are always context-sensitive and can be both fortitive and lenitive (see below for a definition of fortitions and lenitions). Paradigmatic processes, for example, produce the subsystem of vowels in a given phonological system, as they "systematically [limit] the phonatory capacities of the oral tract in order to select preferred points of vocalic articulation", whereas syntagmatic processes "derive phonetic realizations from underlying representations" (Hurch 2006: 542). Consider nasal vowels: paradigmatically, nasal vowels are dispreferred, and if they are part of a vowel system, their oral counterparts will also always be part of that system. Syntagmatically, by contrast, in the context of nasal consonants, nasal vowels are preferred.

The central dichotomy of two types of processes in NP is based on their causality: fortitions (also strengthening, foregrounding processes) are distinguished from lenitions (also weakening, backgrounding processes). While fortitions are centrifugal and enlarge the perceptual distance between sounds – meaning more effort is required for the speaker to produce a sound – lenitions are centripetal and "embrace all assimilatory tendencies which make pronunciation less expensive" (Hurch 2006: 542), which renders an utterance more difficult for a listener to understand. These two types of processes trace back to the antagonism between keeping to a minimum the efforts for the speaker in production vs. for the hearer in perception. We will notice a parallel situation regarding the needs of writers vs. readers in Natural Grapholinguistics.

Fortitions and lenitions are not mutually exclusive, and their application is ordered. Fortitions apply first, followed by lenitions (cf. Donegan & Stampe 1979: 153; Hurch 2006: 542): "Fortitions apply to enhance the divisions of the prosodic score and the clarity of intended sounds, and then Lenitions apply to enhance the fluency of the sequence of sounds"; thus, fortitions make sounds "more like themselves" and lenitions make sounds "more like adjacent sounds" (Donegan & Stampe 2009: 2).[33] Preferred contexts for fortitions are 'strong' contexts such as initial positions and stressed syllables, while lenitions preferably occur in 'weak' positions such as final positions or unstressed syllables (cf. Hurch 1988: 13).

Dressler (1984: 33; 1996a: 43) mentions another dimension of fortitions and lenitions that I will return to later, and claims that the interplay between them is not only determined phonetically but also socio-pragmatically: for example, the degree of formality of a speech situation can influence how the speaker acts linguistically. Accordingly, in a formal situation that might be affected by attempts to be polite, a speaker will likely realize fortitions in his speech in order to make perception less expensive for his addressee. In informal situations, on the other hand, lenitions may prevail over fortitions.

1.2.2.2 Acquisition of processes: Innate vs. emergent and self-organizing

The ontology of processes has been a matter of much debate (cf. Nathan 1999: 314-316). As already mentioned, in Stampe's original presentation of the theory, natural phonological processes are said to be 'innate'. This seems, at least superficially, like one of the few features the theory shares with the generative paradigm. This claim of innateness has led to criticism from within Naturalness Theory; however, according to Nathan (1999), it is all a big misunderstanding (cf. also Bjarkman 1975: 60). Nathan claims that Stampe "used the word 'innate' in a highly non-prototypical way that ensured maximal misunderstanding" and that what he truly meant was 'emergent' (Nathan 1999: 314). The latter claim corresponds with Donegan's (2002: 59, my emphasis) careful statement that processes are "innate *or* emergent".

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[33] Cf. also Wojcik (1976: 47), who remarks that "syntagmatic processes destroy sequences of segments, and paradigmatic processes destroy individual segments".

Indeed, they are 'innate' in the sense that all humans are born with the same vocal tract, the same "hardware" (but see footnote 32), and consequently, they come up with the same solutions to cope with the limitations of that hardware. The phonological processes are, as their name suggests, *natural* responses to physiological restrictions. It is these physiological restrictions that are innate.

Donegan & Stampe (1979: 130) hold that there is "no evidence that processes are learned", and *being learned* is one of the attributes they ascribe to the unnatural rules which they contrast with natural processes. How, then, are processes acquired – how do they 'emerge'? According to Nathan (1999: 315, my emphasis) they "are *discovered* as we try to use our vocal tracts". What is acquired, however, is not the processes themselves, but the "constraints on the processes" (Donegan & Stampe 1979: 147) in that children must 'discover' which processes to inhibit when acquiring the phonology of a given language. Indeed, Donegan (1985b: 26) cleared up many possible misunderstandings regarding acquisition by stating that in NP,

> the child begins with a set of phonological processes. These have been called innate, in the sense that they are immediate, direct, or natural responses to phonetic difficulties which result from the form and abilities of the human vocal tract and perceptual mechanisms. The claim that natural processes are innate does not imply that they represent some genetically-transmitted neural program; to say that they were innate in this sense would explain nothing. Instead, what is meant is that because of the (genetically-transmitted) physical abilities and limitations of human speakers, some combinations and sequences of phonetic features are more difficult than others,[34] and the substitutions that speakers make (in the mental processing of their speech) to ease these difficulties represent natural processes.

In emphasizing that natural processes are not genetically-transmitted neural programs, she underlines the discrepancy between the uses of 'innate' in NP and in generativist circles. Interestingly, as anticipated above, most of the criticism against the (misunderstood) notion of 'innate' proposed by Stampe and his immediate followers – which was termed the 'strong claim' – came from *within* Naturalness Theory.

As one of the critics, Dressler (1996a: 48) promotes the 'weak claim' as an alternative (to what, by and large, amounts to a straw man-'strong' claim[35]), in which "(substance-based) universal preferences when available to a child at a given stage of extralinguistic and linguistic maturation can be taken up by the child even when contradicted by language-specific facts equally available to the child". Stemming from his work for other components of Naturalness Theory, Dressler (2009: 39) promotes the constructivist model of self-organizing processes which "assumes an interplay of genetic preprogramming and of selecting and evaluating postnatal information within and among preferentially coupled neuronal assemblies (which develop into interacting modular systems)" (for a similar view, cf. also Balas 2009: 51).

Since the acquisition of phonology is not in the focus of this thesis, and also because it differs fundamentally from the acquisition of writing, this question of innateness is not discussed further at this point.

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[34] Keep in mind this portion of the quote: "some combinations and sequences of phonetic features are more difficult than others", as it will be central to the discussion below of whether naturalness is an evaluative notion in NP.

[35] Admittedly, there *are* problems with the non-misunderstood meaning of 'innate' that Stampe had intended, since, as Dressler (2009: 38) mentions, some "natural processes observed in small children are totally absent first, or initially appear only in a very limited and even irregular way". This challenges even the physiological reading of 'innate' that claims that processes are innate because they are universal in a biological sense, for this reading would predict, among other things, that all processes are present right away, although, crucially, the vocal tract and neuronal control differ in infants and adults.

1.2.3 The notion of *naturalness*

As elaborated in Section 1.1, the use of the term *natural* in Naturalness Theory is not unproblematic as it is prone to be misinterpreted. Hence, it is necessary to make its meaning explicit for every context in which it is/was used. Donegan & Stampe (1979: 127, emphasis in original) explain their understanding of the term in stating that NP

> is a *natural* theory […] in that it represents language (specifically the phonological aspect of language) as a natural reflection of the needs, capacities, and world of its users, rather than as a merely *conventional* institution. It is a natural theory also in the sense that it is intended to *explain* its subject matter, to show that it follows naturally from the nature of things […].

All of the aspects captured by this definition are constitutive not only of NP, but of Naturalness Theory in general: it is a theory which focuses on explanation, and language reflects human needs and is shaped by human capacities. So, while this passage echoes the broader definition of naturalness carved out in Section 1.1, the parenthesis clearly implies that the focus lies on phonology,[36] and thus, within NP, "naturalness is a matter of phonetic motivation" (Donegan & Stampe 1979: 141). This relatively straightforward claim has invited a discussion of two important questions I want to elaborate further: (1) whether NP is essentially a phonetic rather than a phonological theory (Section 1.2.3.1), and (2) whether naturalness within NP is indeed only a matter of phonetic articulation and perception, or whether it should account for cognitive factors as well (Section 1.2.3.2).

1.2.3.1 Is NP a phonetic theory?

Regarding the first of these questions, restated in the title of this section, it must be noted that underlining the relevance of 'phonetic motivation' does not necessarily entail that "Natural Phonology [is] just phonetics" (Dziubalska-Kołaczyk 2012: 199). This is a reductionist claim used to attack NP's status as a *phonological* theory.

NP has been criticized for questioning the abstractness of phonology, leading Bertinetto (1987: 357), who, in the paper in question, calls himself a phonetician, to "remind phonologists of the essentially abstract nature of their own domain of research". Naturalists such as Hurch (1988: 23, my translation), however, stress the concreteness of phonology, claiming that "'not actually material' does not equal 'not real'". As we saw above, mental intentions in NP are considered *real*, and how these mental representations are materialized is phonetically conditioned. Accordingly, adherents of NP insist that "[p]honology is inseparable from phonetics" (Donegan & Stampe 2009: 19) in that phonetics takes on a "motivating or explanatory or execution-al/implementational role" (Dziubalska-Kołaczyk 2012: 202). However, the core of the theory remains phonological, for as Donegan (2002: 57, my emphasis) puts it, "if processes are treated as *entirely* phonetic effects, their systematic and perceptual characteristics are not captured". These 'systematic characteristics' allude to how the phoneme and the question of phonological representation are treated in NP – they are mental, functional (see above).

Hurch (1988: 8) encapsulates the answer to the question whether NP is phonetic when he writes that the "mental reality" of phonology finds its "material basis" in articulatory and perceptual capacities of humans: in phonetics.[37] To sum up, in NP, "phonetics does not merely follow phonology, but *pervades* it" (Donegan 1992: 74, my emphasis). This, however, should not be misread as a reduction of phonology to phonetics.

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[36] Cf. also Donegan (1992: 73), who, in an encyclopedia article, writes that the object of NP "is phonology in the traditional sense: regular linguistic behavior that is phonetically rather than morphosyntactically conditioned".

[37] „Natürliche phonologische Prozesse sind Lautsubstitutionen, deren mentale Realität ihre materielle Basis in den artikulatorischen und perzeptuellen Fähigkeiten des Menschen findet".

We will reencounter an analogous question with respect to the relationship between graphematics and graphetics. I will show that, in principle, graphematics cannot be seen independently from graphetics. However, they are still more easily separable than phonology and phonetics, which is why there can be both a Natural Graphetics and a Natural Graphematics, compared to only Natural Phonology for the domain of spoken language.

1.2.3.2 Parallels between NP and other components of Naturalness Theory

> This view, that phonology per se is natural, stands in complete contradiction to most current grammatical theories. (Hurch & Nathan 1996: 233)

The second question mentioned above – whether not only phonetic, but also cognitive explanations should be permitted in NP – is central for the assumption of a coherent Naturalness Theory that encompasses more ‘components’ than just NP: Natural Morphology and Natural Syntax, for example, but also the proposed Natural Grapholinguistics. While Dressler (1984, 1996a, 2009) and Auer (1990), among others (such as Dziubalska-Kołaczyk), are in favor of incorporating a cognitive dimension to NP, “Stampe and his closest followers have never considered this issue” as “American Natural Phonology has not been interested in the parallels with other levels” (Hurch & Nathan 1996: 238). Hurch & Nathan (1996), as followers of the original Stampean branch of NP, indeed contend that explanation in NP should remain a solely phonetic matter. I want to address the arguments of both sides in detail because they bring up issues that could potentially have major repercussions for Natural Grapholinguistics. In this context, the following questions arise: (a) firstly, whether “phonology [and possibly analogously, graphetics, D.M.] is different from the other components of grammar” (Hurch & Nathan 1996: 231); (b) secondly, whether one should posit two distinct schools of NP, original Stampean NP or *Standard Natural Phonology* (SNP, cf. Dziubalska-Kołaczyk 2006: 4) and what has sometimes been called *Modern Natural Phonology* (MNP, cf. Dziubalska-Kołaczyk 2007: 72), implying that NP has not fundamentally changed, but that a separate, distinct branch has splintered from it; and (c) thirdly and finally, whether the absolute naturalness concept of NP is reconcilable with the scalar evaluative naturalness concept first proposed for Natural Morphology and later secondarily applied to NP, or whether the differing naturalness concepts have indeed become “disparate and perhaps partially incompatible” (Hurch & Nathan 1996: 231). In many regards, these three questions overlap, which is why they cannot be answered completely separately.

The central figure of a cross-component Naturalness Theory or ‘Natural Linguistics’ is Wolfgang U. Dressler. Having – together with other linguists – successfully launched a second naturalist enterprise, Natural Morphology (see Section 1.3), and later another, less-received one, Natural Textlinguistics (see Section 1.4), it was Dressler’s wish to find the common denominator that links these components to original NP, focusing on how naturalness can be explained coherently in all of them. For Natural Morphology and Natural Textlinguistics, the answer is: naturalness is explained cognitively, but also communicatively (‘socio-pragmatically’, to use Dressler’s terminology). What serves as a metatheory in these branches is Peircean semiotics, with the – very simplistically phrased – core axiom that the ‘better’ the semiotic relation between a signans and a signatum, the ‘better’ the cognitive fit, and the ‘more natural’ a linguistic structure/element/phenomenon. What Dressler (1984: 29) envisioned was a “bridge theory” between the components, and his aim was to

> provide NP with a semiotic foundation which represents a metatheoretical basis, in contradistinction to those other phonological theories which have none; the same metatheoretical basis is valid for Natural Morphology as well.

While a shared metatheory and explanation for all components, including phonology, might be desirable, the crucial question is: are they necessary? And more pressing even: are they possible? Dressler (1996a: 41) appears to think so, claiming “it is no longer possible to develop Natural Phonology ‘in splendid isolation’” and that the goal is “to devise both a consistent metatheory and compatible methodologies for all of [the components, D.M.]”. The – per Hurch & Nathan

(1996: 231) 'secondary' – application of principles from other components to NP is justified by the assumption that "if cognitive, psychological and sociopragmatic bases play a role in NM [= Natural Morphology], NS [= Natural Syntax], and NT [= Natural Textlinguistics], it is highly unlikely that they were negligible in NPh [= Natural Phonology]" (Dressler 2009: 34). Advances in the other components should be made available to NP, as the components should not exist "in mere peaceful coexistence" (Dressler 1996a: 51). Auer's (1990: 13) views are in agreement with Dressler's, as he claims that "[o]nly if we see naturalness in a broader, cognitive sense, it is possible to develop a unified theory of naturalness comprising all levels of linguistic structure". He argues that for prosody, a domain intricately connected to phonology, "merely perceptual and articulatory explanations of the low-level kind are not enough to distinguish natural from non-natural phenomena" (Auer 1990: 14). Note also that Rhodes (1973: 530, my emphasis) speaks of processes as "physiologically *and mentalistically* motivated" and that, as elaborated above, the mental domain does play a role in explaining phonemes and processes. However, in calling natural phonological processes universal, Donegan & Stampe (2009: 6) emphasize that "[t]hey are universal because the human vocal and perceptual apparatus is universal – not because they are somehow part of the human brain". This reads as either a strong rejection of cognitive explanation or, more specifically, as a criticism of the (predominantly generativist) view that there is a separate 'module' for processes in the human brain. It is very likely the latter.

(a) Hurch & Nathan (1996: 235, 245) indeed argue that "phonology is different" than other levels of language, which they mainly justify with the observation that "it is the only one that has direct physical consequences" (242). It is important to note that they in no way criticize the use of semiotics as a metatheory in the naturalist treatments of the other, "more abstract levels of language" (245). What they do object to, however, are the attempts to place NP in that same category. Whereas Dressler (1984: 35) interprets "processes and rules as signs" and highlights semiotics' fit for phonology by claiming, for example, that "the distinction between foreground [= achieved by fortitions or, per Dressler, foregrounding processes, D.M.] and background [= the result of lenitions or backgrounding processes, D.M.] corresponds to the semiotic distinction between figure and ground, a distinction which sharpens the contours of what is to be perceived" (33), Hurch & Nathan (1996: 235) strongly disagree. They maintain that "phonology per se is non-semiotic". Processes, they argue, do not have a signaling function. While they admit that the question which phonemes make up meaningful units such as morphemes is definitely of semiotic nature, NP is not interested in that question, but rather asks "what gestures, acoustic impressions and so on are available in the first place" (235), a question that is not semiotic, but articulatory and perceptual in nature. Singh (1996b: 246) very aptly sums up their arguments when he remarks that "[s]emiotics may not provide the right calculus for interpreting 'hardware' matters". For some linguists (and naturalists), such as Gaeta (2006: 9), the difference between phonology and other linguistic levels is so evident that it is not questioned at all:

> The crucial difference is evidently given on the one hand by the notion of sign, and on the other by the strictly phonetic motivation underlying phonological markedness. Therefore, the other levels entirely lie within the realm of semiotics, whereas phonology is only indirectly connected with it.

With the indirect connection that he cites he most likely alludes to the above-mentioned fact that units such as morphemes, which are signs, and consequently, lie in the realm of semiotics, consist of phonemes, which is why phonology is indirectly connected with semiotics.

However, on another level than the merely biological, semiotics might be of relevance for NP after all. Remember that in Section 1.1, we defined naturalness both in physiological/cognitive and socio-pragmatic terms, a two- or threefold[38] explanation that also stems from Dress-

[38] Whether it is interpreted as two- or threefold depends on whether cognition is also seen as a part of human biology. If it is, it can be categorized together with physiology and we have physiological and cognitive explanation as 'biological explanation' – which I will term *processing* explanation – on the

ler's more general naturalist enterprise. It is the first (or first two) of these, the physiological and cognitive basis of naturalness, where Stampe's (encompassing Hurch and Nathan's) and Dressler's views diverge: phonology, as the 'lowest' abstract level of language and simultaneously the link to its material realization in speech, is mainly governed by articulation and perception, whereas other levels such as morphology or syntax are governed both by cognition, and, secondarily, because of the double articulation of language and the fact that morphemes have a phonological representation, by articulation and perception. It could be argued, thus, that phonology can be a matter of cognition and, for that reason, subject to semiotic analysis, too, granted that it is studied specifically through the lens of another linguistic level, most importantly morphology.

But let us now turn to the other basis of naturalness that is fundamental in Naturalness Theory since it interprets language as a tool for communication: sociopragmatics. Under the aspect of sociopragmatics, phonology is not so different, after all. As mentioned in Section 1.2.2, natural phonological processes do not always apply, and as Dressler (1984: 33f.) pointed out, the phonetic output can vary greatly depending on the degree of formality of a given communicative situation: in casual speech, there is a tendency for more lenitions, while in formal speech, the needs of the hearer are central, likely leading to fortitions by the speaker (cf. also the hyper- and hypospeech theory by Lindblom 1990).

To sum up this point of the discussion for NP: *when* a natural phonological process applies, Hurch & Nathan's (1996: 235) arguments are valid, and, for example, "the process devoicing obstruents is an expression of the purely physiological fact that it takes extra effort to maintain voicing during obstruent production". This does not make it – neither the process nor the phonemes that take part in it – a sign, they rightly argue. However, the question *whether* a process applies can definitely be of semiotic nature, and, consequently, the application or non-application of a process can become a sign signaling characteristics of the speech situation in which the speaker and the hearer find themselves in or even of the speaker and hearer themselves. Biologically, NP is different than the other components, but socio-pragmatically, it is similar in important respects.

To draw a parallel to writing: the above-mentioned situation is predicted to be similar for Natural Grapholinguistics, more precisely for its subbranch Natural Graphetics. If we, for the time being, assume that – in handwriting – there are natural graphetic processes that are motivated by the physiological limits of the writing hand in combination with the materials used, then the visuo-graphic product that results from the writing process will, on the one hand, reflect these limitations. On the other hand, on a social dimension, it might "signal" more. As Schreiber (submitted) has shown in his study of Japanese letter writing in pre-modern times (11^{th}–13^{th} centuries), cursivized handwriting signaled not only more "informal" writing situations but more importantly, social hierarchies: if someone from a socially higher level addressed a person from a socially lower level, their handwriting could become very cursive, whereas when a person addressed someone from the same social level or a higher social level, handwriting tended to be a lot more meticulous, and the shapes of the characters resembled their prototypical shapes more closely. This, assumedly, eased perception on behalf of the addressee, i.e. the reader. Schreiber termed this phenomenon *visual politeness*. In this context, the "quality" of the written product was not dependent on physiological conditions, but was determined socio-pragmatically – here, the application of graphetic processes functions as a sign.

(b) The answer to whether NP changed significantly over the course of time, or whether a second subbranch separated from it – the latter being a view that Wurzel, for example, ad-

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one hand, and socio-pragmatic explanation on the other. If cognition is seen as separate from physiology, we have a three-fold distinction.

heres to[39] – depends on the perspective taken. Since, as mentioned above, Stampe and his followers never truly concerned themselves with NP's possible parallels with other components of grammar, they also did not incorporate into their own works the findings that resulted from NP's integration into the broader context of Naturalness Theory propagated by Dressler and others. In their 2009 paper *Hypotheses of Natural Phonology*, Donegan & Stampe still adhere to the same principles of the theory that had shaped it from its first inception. From this perspective, NP did not change. In contrast, Dressler and, most vocally, Dziubalska-Kołaczyk, probably see their extensions of NP as developments of the traditional Stampean formulation of NP. However, as Hurch & Nathan's (1996) above-mentioned objections clearly show, NP is – at least in part – different, and this definitely warrants assuming two separate versions of NP that Dziubalska-Kołaczyk herself calls *Standard Natural Phonology* and *Modern Natural Phonology*, respectively. I would not say that Dressler and others' modification is more modern (even if 'modern' is to mean 'more recent'), as the crucial difference to Stampe's NP is the attempt of a semiotic explanation. Thus, something along the lines of *Semiotic NP* would be more fitting, whereas – being the traditional branch – Stampean NP should simply be referred to as *Natural Phonology* without any additional attributes.[40]

One question remains: if NP is regarded as – at least partially – different from the other components of Naturalness Theory, can there even be a coherent 'Naturalness Theory', and what is the thread that holds the heterogeneous components together? I argue that yes, there can and should indeed be a comprehensive 'Naturalness Theory' that encompasses even non-semiotic (Stampean) NP. There might not be a single metatheory that holds all of them together; however, what Donegan & Stampe (1979: 127) stated when conceiving NP, already quoted above, is definitely true for all subbranches of Naturalness Theory: "[it] is a *natural* theory […] in that it represents language […] as a natural reflection of the needs, capacities, and world of its users". While this is arguably a very general definition, it glues NP to other components such as Natural Morphology and Natural Syntax even if NP is different from them in fundamental ways. Wurzel (1988: 100, my emphasis), one of the original natural morphologists, agrees on this point, holding that naturalness theory "starts from the fact that the various components of the language system are coined by naturalness principles *specified for them*, which results in a relative autonomy of individual components". This, however, does not undermine the fact that they are all components of the same theory.[41]

(c) The final facet of this discussion is probably the most pressing of them all: is *natural* an absolute or an evaluative notion? The attempts at defining it in Section 1.1 mention both as possible readings of the term (*natural*$_{1a}$ as absolute and *natural*$_{1b}$ as gradual), but, in the end, give precedence to the gradual, evaluative view. I want to argue that the belief that these two readings are incompatible falls prey to a lack of precision in *what* is to be considered natural: processes or products? Larger chunks of linguistic elements or segments? In this context, Hurch (2006: 541, emphasis in original) states "naturalness is never claimed to be an evaluation device for *systems*"; elsewhere, Hurch & Nathan (1996: 232) claim that "all that is phonological is natural" and "whatever is phonologically natural is natural to the same degree" (236). In the same vein, Hurch (1988: 10) cites Stampe and his observation that it is heuristically pointless to

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[39] Cf. Wurzel (1988: 99), stating that Natural Morphology "increasingly developed its own theoretical profile which – by the way – also applies to natural phonology in Europe pursued in close connection with natural morphology".

[40] Labelling the two branches *American Natural Phonology* and *European Natural Phonology*, respectively, is also not accurate, since this geographical distinction might correctly grasp where the two branches originated, and 'synchronically', it might express a tendency, but it is not to be understood absolutely: take Hurch, for example, who is a European linguist but identifies himself as a Stampean – "American" – naturalist.

[41] Cf. also a passage from the influential *Leitmotifs of Natural Morphology* which mentions "the relative autonomy of the various components of the language systems" and "the tendency of each component to follow its own principles of naturalness" (cf. Dressler et al. 1987: 8).

rank the naturalness of permissible forms,[42] and indeed, Donegan & Stampe (2009: 6) mention in a footnote that they reject the interpretation of *natural* as an evaluation device that survives in "European naturalness theory" (= which was referred to as *Modern NP* above). However, although they express themselves very sparsely on this topic, they mention that for morphology, thanks to "semiotic criteria", *natural* could be regarded as an evaluation device.

While at first glance, these quotes all seem to point to the same thing, they, as mentioned above, confound *absolute* naturalness (= possibility to process) with *gradual* naturalness (= physiological/cognitive/social ease/effort to process) and additionally refer to two very different ideas: naturalness of whole systems (= global naturalness) vs. naturalness of elements within these systems (= local naturalness). As elaborated in Section 1.1, in the absolute reading, everything in language (in general) must be natural, i.e. everything must meet our human needs in some way, otherwise, it would not exist in language. This, of course, subsumes all the individual language systems, and in turn, all of the structures, elements, phenomena etc. found in them. This is what Hurch partially refers to when he claims that naturalness is not an evaluation device for systems – we will see, however, that he only means phonological systems and not entire language systems with all their respective subsystems. Indeed, all phonological processes are treated as natural in NP, as are all the realizations that result from them. Interestingly, although processes are reflections of difficulties the speaker experiences in articulation, Hurch & Nathan (1996: 236) claim that a "speaker of German does not find it easier to pronounce an [i] than to pronounce an [y], or an [a] easier than an [e]", alluding to the fact that segments cannot be compared as to the effort needed in their production. Is the same true for voiced vs. voiceless obstruents, the former of which are often substituted by the latter? If the answer is: yes, they are equally "natural", then NP obviously holds that one cannot compare isolated segments or phonemes with respect to naturalness. All of them are natural in an absolute sense, and it is unfeasible to compare their gradual naturalness, since all of them are considered equal.

However, *in a given context*, one of them *must* be more natural than the other, otherwise there would not be a reason for a process (such as obstruent devoicing) to be applied. Remember the portion of the quote I asked you to keep in mind, Donegan's (1985b: 26) "some combinations and sequences of phonetic features are more difficult than others". It cannot be denied that this statement clearly invokes an evaluative dimension. It is not segmental, however, and with that, it is not paradigmatic: Hurch & Nathan (1996: 234) give the example of the combination of a voiceless fricative plus a voiced stop (such as /s+d/), and show that in Basque, there is a progressive assimilation, resulting in voiceless /st/, whereas in Spanish, there is a regressive assimilation, resulting in voiced /zd/. For NP, "both are equally natural, insofar as they eliminate a common articulatory difficulty". This proves that the question whether /t/ or /d/ are more natural does not even arise in NP – processes apply *asegmentally* (cf. Donegan 2002: 61), and all processes are natural.[43] For NP, thus, any different naturalness values, for example of /t/ vs. /d/, are epiphenomenal.[44] They are merely reflections of the fact that articulatorily, *in a given context*, one element is preferred over another. Thus, sometimes /d/ might become /t/ and this is natural, and some other times, /t/ turns into /d/, and that is equally natural. NP argues, however, that it cannot be claimed that /t/ is *always* gradually more natural than /d/. As segments, both are natural in an absolute sense, and that is the end of the story.

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[42] „Doch ist es, wie Stampe […] argumentiert hat, heuristisch müßig, die Natürlichkeit zulässiger Formen gegeneinander abstufen zu wollen" (Hurch 1988: 10).

[43] However, this example shows that in phonetic terms, the sequence voiced+voiced or voiceless+voiceless is more natural than voiceless+voiced. This implies that if naturalness could be seen as an evaluation device in NP, it can only function syntagmatically.

[44] Cf. also Stampe (1973: 52) in his comments on Chapter 9 of Chomsky & Halle's (1968) *Sound Pattern of English*: "[…] marks, and markedness conventions, are mere appearances, and […] what underlies the impression of reality they bear is, in fact, the innate system of natural processes".

Another interesting (apparent) contradiction found within NP is that it defines not everything in language as natural, but truly only *what is phonological*: the morphonological rules (cf. Section 1.2.2.1), although they are in general not treated extensively in NP, are not regarded as natural. This could be a reflection of the fact that (see (a) above) NP operates with a solely articulatory and perceptual definition of *naturalness*, and an integration of morphology or even just a link between morphology and phonology would require extending the picture to include cognitive naturalness as well. A morphological structure can be (and per NP's definition of naturalness, *must* be) cognitively natural in order to occur in language. However, its naturalness does not stem from phonetics, but cognition. Thus, in NP, all that is phonological is natural, and – assumedly – all that is not purely phonological is not considered natural because it involves the contribution of cognitive abilities. Thus, phonemes, syllables, larger phonological units, etc. cannot be gradually evaluated as more or less natural, as their occurrence in language alone and their underlying phonetic motivation make them natural.

This, of course, could just be another reflection of the fact that "phonology is different". In the other components of Naturalness Theory, *naturalness* is regarded as an evaluation device. In these components, as emphasized, the basis is not phonetic, but cognitive. Again, one could argue that *everything* occurring in language must also be cognitively natural for it to even occur – and indeed, in the absolute sense, everything must be natural. However, cognitive motivation is more abstract than phonetic motivation, and other components of language lack the "direct physical consequences" of phonology.[45] The concept of naturalness in other components, mainly Natural Morphology, will be discussed below, but let me explain briefly at this point why an absolute naturalness concept is futile for the analysis and comparison of scripts and writing systems – and why, perhaps, grapholinguistics, just like phonology, is different.

As Rogers (1995: 31) put it, "some writing systems are better than others". This claim is obviously very different from the claim presented above that all phonological systems are equally natural. Of course, there are crucial differences between phonologies and writing systems, the most fundamental being that phonology is a *primary* linguistic level. It is a level of language in general. Without it, language could not function, and it is the basis of morphology, syntax, etc. It is *not* just the basic level of one of the modalities of language, namely speech; quite to the contrary, it is the abstract basis of *all* modalities of language, including writing (for a discussion of the relation between speech and writing, cf. Section 2.1). Writing, thus, is *secondary*, underlined by the fact that the linguistic level of graphematics (and with it, the level of graphetics) is optional. This secondary nature of writing allows for a linguistic evaluation of different writing systems, what I will call the *linguistic fit*: how well do writing systems "fit" their respective languages? This is a question for which the semiotic metatheory will come in very handy, as graphemes are treated as signs relating signata and signantia. Unlike in NP, where phonemes are mental sound intentions (cf. Section 1.2.1), graphemes cannot just be mental graphic intentions (mental basic shapes), because they alone would not be linguistic units, just graphic shapes. Thus, when writing, the writer needs to have in mind what he wants to do linguistically with a given graphic shape: with what he writes, he needs to refer to another linguistic level, something speakers do not have to do in speech since what they utter are already linguistic units.[46] Thus, while the question "does a phonological system fit a language" is abstruse, the question "does a writing system fit a language" is clearly justified within Natural Graphematics, because unlike phonological systems and phoneme inventories, graphematic systems and grapheme inventories are not (directly) based on physical limitations. They are

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[45] Again, I speak here only of classical, Stampean NP. In Modern NP, which was embedded in a semiotic metatheory, naturalness is both phonetically and cognitively motivated, and thus, it is interpreted as a scalar notion.

[46] Of course, speakers produce sounds in order to make up larger utterances that bear meaning, but the phonemes that are materialized by these sounds themselves do not refer to anything else. Graphemes (which are materialized by concrete graphs), on the other hand, do.

rather based on the association of the written level with other linguistic levels, and this association can, as Rogers said, be "better" in some systems than in others.

On the other hand, the proposed Natural Graphetics is, in some respects, very similar to NP. It can be assumed that the shape of the concrete materialization of writing is at least partially graphetically motivated – that is, by articulatory, and probably more importantly, perceptual restraints of writers and readers. However, even at the merely material level, there is a striking difference between Natural Graphetics and NP: while (it is assumed that) all the (basic)[47] sounds that humans can possibly produce are listed in the IPA, which can be used to describe the phoneme inventories of the languages of the world, there is no such list of possible graphic basic shapes.[48] As will be discussed in detail in Section 3.3, this is due to the fact that the articulators involved in writing are not subject to (the same kind of) limitations as the articulators in speech. Thus, the visual variety and variation in the scripts used for the writing systems of the world are enormous. And, to a large degree, it is arbitrary. Two interesting questions arise here: first, whether one can assume natural graphetic processes at all, and if because of the differing shapes in the scripts of the world they are all script-specific as opposed to the universality of natural phonological processes; secondly, whether the visual variation across scripts warrants the introduction of an evaluative notion of naturalness, since – as mentioned above – there is not "one script" like there is "one sound inventory" (the IPA) which collects all scriptual units that can occur in writing systems. If we shift the focus from articulation to perception, then the answer to this latter question becomes more obvious: I will argue that an evaluative and writing system-specific concept of naturalness is indeed adequate, since the effort involved in perceiving basic shapes of different complexity (even within *one* script, such as the Roman script) is assumed to vary. This 'effort involved' invokes a second fit, the *processing fit*, which subsumes the *articulatory/perceptual fit* as well as the *cognitive fit* (see Sections 3.2.2 and 3.3.2).

There is an additional dimension of complexity involved in the analysis of writing systems. Since graphemes are signs – relations between basic shapes and linguistic units – they can be evaluated with regard to certain parameters. Questions in this context include those of iconicity: is there a pictographic relationship between the signans and the (meaning of the) signatum, e.g. between the visual form of the basic shape |木| (= signans) and the meaning of the Mandarin morpheme *mù* 'tree' (= signatum)? Are similarities in the signata reflected in similarities in the signantia? Take the basic shapes |m| and |n|, which are visually similar. In most writing systems in which they are used, they both refer to nasal sounds. Does an increase in the complexity of the signatum result in an increase of complexity in the signans? These questions highlight that since writing is secondary and its units refer to other units, the semiotic criteria first proposed in Natural Morphology (see Section 1.3) are expected to be fruitful for it. These questions, in comparison, are not useful for NP, since phonemes are not signs and do not refer to anything.

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[47] I use the term 'basic' here to highlight the conceptual analogy of basic sounds to the basic shapes of writing that will be introduced in Section 2.2.1.2. The sounds listed in the IPA are not to be understood as concrete physical manifestations of sounds, but rather as abstract sound categories that subsume all the phones – the concrete material realizations that for phonetic reasons can be classified as belonging to this sound category. The same applies for graphs which represent the realizations of basic shapes (cf. Section 2.2.1).

[48] Crystal (1997: 23) bemoans the lack of such a list and asks: "But why should there not be an International Graphetic Alphabet, identifying all the marks the human hand can make that are capable of playing a contrastive role in some language – the array of straight lines of varying length and orientation, curves, dots, thicknesses, and so on, which when combined result in written letters, syllables, and logograms?" Considering the richness of the visual variety in the scripts of the world, the idea of a collection of basic shapes is illusory (or at least associated with a massive amount of effort). However, what Crystal implies here is a list of components of basic shapes (which I will call elementary forms), and his wish for a collection of these might not be as illusory.

In conclusion, one could say that NP is indeed different because phonology is different, and this justifies the rejection of a semiotic metatheory and cognitive explanations for phonological phenomena[49] – save for the socio-pragmatic dimension, for which semiotics is certainly useful. However, for other 'components', meaning other linguistic levels, semiotics is adequate, and cognition is relevant. Summing up, one could invoke the "Cartesian mind/body dichotomy" (Singh 1996b: 247), with phonology belonging to the body and other linguistic levels to the mind. Grapholinguistics, as we have seen, is different, too, as it adds a layer of complexity.

1.2.4 NP as a functional theory

As a functional and "anticonventionalist" theory (cf. Dressler 1996a: 44), NP (and Naturalness Theory in general) makes a categorical stand against the neo-positivism of the generative paradigm (as well as the reductionist descriptivism of structuralism, cf. Elsen 2014: 175). Accordingly, Edwards & Shriberg (1983: 87) call NP a "post-generative approach". Ironically, it was often terminologically and, in turn, conceptually mistaken for the similarly titled *natural generative phonology* (as developed by Vennemann 1972; 1974; Hooper 1976), which was prominent around the same time as NP (cf. Hurch 1988: 5-7). Although a detailed comparison between these two approaches is not within the scope of this thesis, it should be pointed out that one aspect in which they differ fundamentally is that natural generative phonology is formalist, while NP is not. In this context, Hurch (1988: 4) notes that NP is not easily conceivable with formal criteria, and that it is precisely this abandonment of all formalism that could have been among the reasons[50] that NP never spread widely and to this day remains a 'non-mainstream-approach' in linguistics (cf. Hurch 1998: 115).

This non-formalist nature of NP can be seen both as an advantage and a drawback, which is reflected in the application of NP to clinical phonology and speech therapy, a field in which no phonological theory has had as much impact as NP (cf. Dressler 1984: 47; Tobin 2009: 176): while the lack of formalism makes NP more accessible to clinicians than formal approaches, it also leads to a certain degree of disorganization. One example for this is, as mentioned above, "that there has not been an effort to draw up a standard list of processes" (Ball, Müller & Rutter 2009: 134), leading to *ad hoc*-assumptions of processes and consequently, widely differing lists of processes. The lack of such a standardized list, however, can on the other hand also be seen as an advantage, as it implies there is no theoretical corset one is forced to stay in. Instead, the theory grants a large degree of freedom to take its principles merely as a basis to arrive at new insights. As Dziubalska-Kołaczyk (2012: 199) acknowledges, "[t]he theory is not hermetic and thus open to enrichments and modifications which do not violate its principles". This reading of the theory, of course, is the reason why it was eventually extended to include other domains of language such as morphology and syntax, and why the present endeavor is even made possible – although whether they together form a coherent theory is another story (see above).

NP is non-formalist, which does not mean it is simultaneously anti-formalist, as Balas (2009) argues since, in theory, a formalization would be possible – it has just never been a priority of NP.[51] And, as Newmeyer (1999: 469) rightly argues, "there is no fundamental incompat-

[49] Note that, admittedly, I have only treated segmental phonology here. As the quote by Auer cited above critically observes, prosody is a different story that might warrant a reevaluation of the question whether cognitive explanation is necessary.

[50] Other reasons named by Hurch (1988: 4) include (1) the – dated – situation that next to phonology, only morphology has been treated within Naturalness Theory, (2) the fact that major works of NP remain unpublished, and that (3) the unusual, but remarkable style of David Stampe's works has contributed to a lacking and partially false reception of NP. The last two points are echoed by Bjarkman (1975: 60), who mentions "the scarcity of published versions of Stampe's work and the resulting confusion over the precise meaning of many of his claims".

[51] But see a kind of formalization in Dziubalska-Kołaczyk (2002b), an approach embedded within NP.

ibility between the central tenets of the formalist and the functionalist approaches". One reason for NP's non-formalism is that formal theories focus on precise description, while functional theories focus on explanation (cf. Balas 2009: 46), which definitely applies to NP. Another crucial difference that needs to be mentioned is that generativists conceive of language as "an innate, autonomous faculty, independent of other cognitive abilities" (Balas 2009: 44), while for functionalists, language is rather non-autonomous and the ability to use language does not differ radically from other human cognitive abilities (for a more detailed description of the differences between functionalism and formalism, cf. Nathan 1999: 307-309). This latter aspect of functionalism is reflected in the fact that external evidence is central for NP, since "an adequate model of language has to involve reference to general conceptual structures and cognitive abilities" (Balas 2009: 44).

1.2.5 External evidence

In NP, data from first language acquisition and aphasic speech are utilized as external evidence. This is clearly reminiscent of Jakobson's *Kindersprache, Aphasie und allgemeine Lautgesetze* (1941). The integration of external evidence happens under the assumption that a greater number of natural processes applies in the utterances and structures observable in these types of speech than in the healthy 'normal' speech of adults. Dressler (1996a: 47) states that NP has been a "pioneer in the systematic use of external evidence on par with internal evidence", and that, in fact, external evidence, in NP, is not external, but *substantive* (cf. Dressler 1984: 47). Since the use of this kind of evidence is even more characteristic of Natural Morphology, it will be discussed in more detail in the next chapter in Section 1.3.3.

1.3 Natural Morphology (NM)

> Not all morphological structures are disseminated equally in natural languages; not all morphological processes and structures are learned at the same time by children; not all morphological structures are similarly affected by language changes; not all morphological structures are equally easily decoded. Notions of this sort have long been current; their meaning, however, is unclear and controversial. (Mayerthaler 1988: 1)

After the establishment of NP, *Natural Morphology* (NM) was developed as the second subbranch of Naturalness Theory. It would eventually become the most prominent – its "most significant achievement" and "the one which has been best worked out" (Gaeta 2006: 8). Its founders are the Austrian linguist Wolfgang U. Dressler and the German linguists Willi Mayerthaler and Wolfgang U. Wurzel.[52] There are different accounts of when exactly NM was first established, but Dressler himself (cf. Dressler & Kilani-Schoch 2016: 356; Dressler 2006: 539) dates the inception of the theory to 1977[53] and states that the theory is based on a chapter in Mayerthaler (1977). The official and public 'birth' of the theory is said to have taken place at the *LSA Summer Institute* of 1979 in Salzburg (cf. Kilani-Schoch 2001: 234).

While the development of NM was given crucial impetus by NP, which is clearly demonstrated by the name adopted for the then-nascent theory,[54] and NM is explicitly considered "a

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[52] At times, Austrian linguist Oswald Panagl is additionally mentioned as a fourth founder (cf. Kilani-Schoch 2001: 234). Together with Dressler, Mayerthaler, and Wurzel, he authored the programmatic *Leitmotifs of Natural Morphology* (1987).

[53] According to Wurzel (1988: 99), NM had begun to emerge as early as "about the mid-70ies".

[54] Dressler was an associate professor at the Ohio State University in 1970-71 and returned there as a guest professor in 1977 (cf. https://www.oeaw.ac.at/npr/links/CV_WUD_deutsch.pdf, March 9th, 2018), which was the time when David Stampe and his colleagues were actively working on NP at Ohio State University (Bernhard Hurch pers. comm.).

semiotically and cognitively based functionalist theory in the continuation of Natural Phonology" (Dressler & Kilani-Schoch 2016: 356), the distinct characteristics of morphology and phonology (cf. Section 1.2.3.2) required taking into account other, additional ideas. The first notable difference between NM and NP concerns their theoretical roots: whereas NP criticized structuralism in a number of respects, NM relies heavily on its "structural heritage" (cf. Wurzel 1988). While Sapir is named as an influence in both NP and NM, additional linguists who are mentioned for NM include the neo-grammarian Hermann Paul as well as August Schleicher and Vladimír Skalička.[55] However, the most important groundbreaker for NM was undeniably Roman Jakobson (cf. Wurzel 1988: 103), and more generally, the Prague School of linguistics. Some even go as far as regarding NM as – at least in part – a product of said Prague School (cf. Lieber 2014).

One of Jakobson's achievements that is constitutive for NM is his treatment of semiotics and semiotic questions regarding language (best expressed in his 1965 article *Quest for the essence of language*), which eventually led to the formulation of a semiotic metatheory for Naturalness Theory (cf. Dressler 1999b; Crocco Galèas 1998: 8-10). Accordingly, it has been claimed that "[s]tructuralism has been united with semiotic studies by Natural Morphologists" (Beard 1994: 2576). The implementation of a semiotic metatheory that relies predominantly on Peircean semiotics is based on the assumption that semiotics has bearing on human cognitive processing of sign systems, and language, of course, is one of those systems (cf. Dressler 1987: 165). An additional aspect of Jakobson's work that proved relevant for NM is the concept of *markedness* that was developed in the Prague School. In NM, simply put, the term *naturalness* is interpreted as a conceptual and terminological synonym of *unmarkedness* (cf. Dressler 2000: 288) – as such, it is considered the "diametrical opposite of markedness" (Wurzel 1994a: 2591; for a more detailed discussion of the notion of *markedness*, cf. Section 1.5.1).

Its integration of semiotics on the one hand and markedness on the other hand leads to a situation in which NM shares similarities and even partially overlaps with other theories or linguistic schools of thought, including *Cognitive Linguistics* (cf. Dressler 1990, but also Nathan 1999 for a discussion of the compatibility of Naturalness Theory and Cognitive Linguistics), modern *Markedness Theory* (cf. Section 1.5.1), and *Usage-Based Linguistics*, which was developed by, among others, Joan Bybee [Hooper], who had also treated questions of morphological naturalness (cf. Section 1.5.4).

In the subsequent sections of this chapter, the central cornerstones of NM will be outlined. Section 1.3.1 focuses on its three *subtheories*. Based on the observation that universal or *system-independent naturalness* cannot explain the synchronic state of morphological systems which exhibit unnatural traits with respect to various parameters, naturalness was also proclaimed at a lower level: the individual system. This led to the concept of *system-dependent naturalness* that relies crucially on the question of what is 'normal' within a given system. An intermediate level is found in *typological naturalness* which explains how different 'ideal' language types such as the agglutinating or the isolating type favor various naturalness parameters while they simultaneously 'sacrifice' others. Section 1.3.2 deals with those *parameters*: as in NM, naturalness is interpreted as an evaluative, gradual notion, linguistic phenomena can be

[55] As additional influences and (often not explicitly acknowledged) forerunners of NM and Naturalness Theory in general, Sakaguchi (1997) names Danish linguist Rasmus Rask, who attempted to create an a posteriori language (*linguaz universale*) free from irregularities and as a result of extensive comparative studies of languages (cf. also Sakaguchi 1996), Danish linguist Otto Jespersen with his early formulation of the conflict between a maximum of communicative efficiency and a minimum of effort (cf. Jespersen 1922; Jespersen is also named by Stolz 1990: 142 in the context of having influenced Naturalness Theory), and Austrian linguists and esperantologists Eugen Wüster and Otto Back, who developed a concept of system adequacy (German *Systemgüte*) that corresponds to NM's subtheory of system-dependent naturalness. Stolz (1990) adds to those John Wilkins, a British clergyman and philosopher who lived in the 17th century. Wilkins used the term 'natural' metalinguistically in a way that echoes its use in Naturalness Theory and pondered some ideas about the nature of language and language change that are reflected in Naturalness Theory.

regarded as more or less natural not holistically, but only with respect to certain parameters. This implies that a linguistic element can never be maximally natural on all parameters at the same time and explains why no linguistic phenomenon can be maximally natural in a gradual reading of the term.

Like NP, NM is a functionalist theory in which language is considered a tool for communication and cognition (cf. Kilani-Schoch 1992: 72). Consequently, Dressler et al. (1987: 11) stress that the concept of naturalness relies crucially on functional explanations. This, in turn, means that an evaluation of linguistic naturalness must be based on extralinguistic foundations, primarily of (1) neurobiological and (2) socio-communicational nature.[56] These foundations determine which linguistic structures can occur in the languages of the world and, in turn, which of these occurring structures are preferred or dispreferred by language users. Based on this assumption, as in NP, evidence – especially, but not exclusively external evidence – is paramount in NM: in Section 1.3.3, several kinds of relevant evidence will be presented. Proponents of NM take the fact that linguistic phenomena differ with regard to their naturalness values on individual parameters as an explanation for local grammatical change: users disprefer less natural phenomena, which are, consequently, more likely to change in order to become more natural or which are eradicated from a language altogether. This is the core of the theory of *natural grammatical change*, NM's contribution to the explanation of language change. Section 1.3.4 closes the chapter by outlining the principles of this natural grammatical change and comparing it with the related invisible hand theory.

1.3.1 Subtheories

NM opposes the reductionism of the *competence/performance* dichotomy and seeks a more fine-grained differentiation of linguistic levels at which naturalness can be evaluated. Based on work going back to Louis Hjelmslev and Eugenio Coseriu, Dressler et al. (1987: 8f.; cf. also Figure 3) assume five levels of linguistic analysis in NM: 1) universals (corresponding with Saussure's *faculté de langage*), 2) types, 3) specific language systems (Saussure's *langue* level), 4) norms, and 5) performance (Saussure's *parole*). The first three of these levels are translated into respective subtheories in NM: I) *system-independent* or *universal naturalness*, II) *typological naturalness* (more frequently labeled *typological adequacy*), and III) *system-dependent naturalness* (also referred to as *system adequacy*). The remaining two levels are to be treated within a sociolinguistic branch of Naturalness Theory (for norms) and a psycholinguistic branch (for performance) (cf. Dotter 1994: 142) – however, both of these branches of the theory have not been elaborated.

While these remaining two levels of norms and performance do not play a crucial role in NM (at least not explicitly), they will receive a more prominent status in the proposed Natural Grapholinguistics,[57] as, together with the level of specific language systems, they form the triad *system–norm–use* (a triad shaped by Hjelmslev's work, cf. Siertsema 1955: 139-144, and Coseriu's work, cf. Coseriu 1970: 53-72). With respect to writing, for which standardization is usually more vital than for speech, this triad is the locus of interesting questions such as: What is systematic, i.e. part of the system? vs. What is standardized, i.e. what is part of a standardization, an *orthography*? And how does variation (in use/performance) factor into all of this (cf. Mesch & Noack 2016 and Section 2.2.3)?

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[56] Dressler (1987: 165) additionally mentions neuropsychological conditions. It is not straightforwardly clear where he draws the line between the neurobiological and the neuropsychological, although I assume that the former includes rather physiological conditions while the latter subsumes cognitive conditions. In Dotter (1994: 142), one finds a different list of factors, including biotic, neurological, psychological/cognitive, and socio-communicative/pragmatic factors.

[57] They were also treated more explicitly in *Natural Textlinguistics* (cf. Dressler 1989: 10f.; Section 1.4.2).

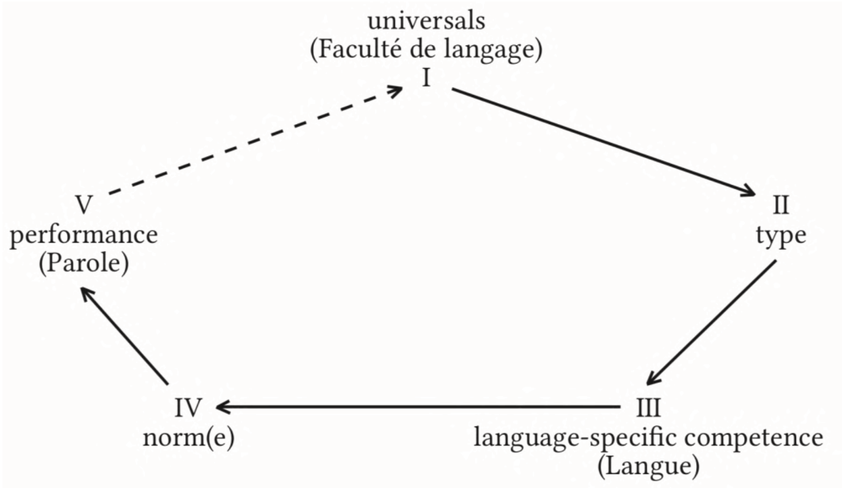

Figure 3: Five levels of linguistic analysis, from Dressler et al. (1987: 9)

System-independent naturalness. The first of NM's subtheories to be developed was system-independent naturalness. First formulated by Mayerthaler (1981), it is considered to be a preference theory à la Vennemann (cf. Dressler 1999a: 136). As such, it represents the foundation of NM. System-independent naturalness deals with universal markedness relations and is based on a reading of naturalness as the optimal symbolization of grammatical functions qua linguistic forms – that is, an optimal semiotic relation between the signans and the signatum. Thus, unlike NP, which is based on articulatory and perceptual constraints, NM is motivated semiotically (cf. Wurzel 1994a: 2593; Bittner 1988: 29). This is based on the assumption that semiotics has a bearing on the cognitive processing of linguistic phenomena. Inversely, it is human cognition that determines what can occur in language and what is preferred in the languages of the world. In the inception phase of NM and in the beginnings of the formulation of system-independent naturalness, what was deemed morphologically natural was identified by uncovering what is "1) common and/or b) learned relatively early and/or c) relatively resistant to language changes or frequently a result of language change" (Mayerthaler 1988: 2). However, frequency, language acquisition, and language change (and the chronology of the latter two) are symptoms, epiphenomena of naturalness and its cognitive foundations. What is natural should thus better be formulated as what is "more or less easy for the human brain" (Mayerthaler 1987: 27). Cause and effect should not be reversed: Naturalness Theory claims that a phenomenon is more frequent in the languages of the world *because* it is more easily cognitively processed by humans, not the other way around (cf. Keller 2014: 159f. for a criticism of what he considers a tautology).

As already mentioned, a given language cannot display the most natural values on all naturalness parameters simultaneously. This is logically impossible since these parameters are in conflict with each other – a situation that is referred to as *naturalness conflict*.

Typological naturalness. This latter concept of naturalness conflict is central to the second subtheory, *typological naturalness*, proposed by Dressler (1988) as a special subtype of system-dependent naturalness (cf. Mayerthaler 1987: 26), which is described below. 'Types' are understood here as ideal morphological types in the sense in which Skalička formulated them: isolating, agglutinating, inflecting, polysynthetic, etc. (for a collection of Skalička's work on typology, cf. Skalička 1979). Maximal naturalness on the parameters of iconicity, uniformity, and transparency (cf. Section 1.3.2), for example, leads to disproportionately long and complex expressions. To give an example, the semiotic relation between form and function of the elements (lexeme and affixes) in a Turkish word such as *evlerimde* 'in my houses' might be biunique, meaning the word is maximally natural on the parameter of biuniqueness; simultaneously, however, this word violates the parameter of optimal shape (cf. Section 1.3.2). In general, agglutinating languages favor naturalness on the parameter of biuniqueness (subsuming uniformity and transparency) by using grammatical affixes (= *forms,* signantia) that each have only one grammatical *function* (= signatum), which is semiotically and cognitively preferred. However, very frequently, more than one grammatical function needs to be expressed in an utterance, which leads to an increase in the number of forms within an utterance/a word, and this, in turn, results in a violation of the perception and processing-oriented parameter of optimal shape (cf. Luschützky 2006: 2344). It follows that for a language type to exhibit naturalness on some of the parameters, it must 'sacrifice' it on others. Accordingly, NM interprets language types as "sets of consistent responses to naturalness conflicts" (Dressler 1999a: 141). What is deemed *natural* for a given type does not necessarily conform with what is natural system-independently, as the level of typological naturalness filters or overrides universal preferences. Chronologically, typological naturalness was the last subtheory to be developed.

Note that not everyone believes postulating this intermediate level between system-independent and system-dependent naturalness is necessary, cf. Wheeler (1993: 99): "I am not convinced there is any independent pressure towards typological consistency [...] over and above that which can be accounted for in terms of system-dependent naturalness".

Even more critical are Fenk-Oczlon & Fenk (1995; cf. also Fenk-Oczlon 1998), who not only deem this typological level of naturalness misleading and unnecessary but find general fault with Naturalness Theory. They take the view that language is an open, self-regulating, and self-organizing system. In line with other functionalists, they propagate the biological analogy of treating language like an organism. They cite Bertalanffy (1970: 221) in claiming that languages are "organized wholes". These organized wholes have to constantly adapt themselves to their environment, which subsumes the entire sociocultural system as well as the human speech (and writing) organs and our cognitive apparatus (cf. Fenk-Oczlon 1998: 175). So far, this view perfectly corresponds with the basic assumptions of Naturalness Theory, which is one of the reasons why Fenk-Oczlon & Fenk (1995) name their enterprise *Natural Typology*.

The crucial difference between their Natural Typology and the level of typological naturalness developed in NM lies in the treatment of naturalness conflicts. Firstly, Fenk-Oczlon & Fenk (1995: 223) criticize that what is "natural" is separated and relegated to different linguistic levels (phonological, morphological, syntactic, ...) and that because of this fixation on isolated components, Naturalness Theory obscures the bigger picture of language as an "organized whole". Secondly, they criticize that deviations from the "natural" are explained with recourse to conflicts between these levels: if there is unnaturalness on the phonological level, this is due to the intervention of the morphological level, and inversely, phonological naturalness goes at the expense of morphological naturalness, etc. This holds also intra-componentially, as not only different linguistic components are in conflict, but also parameters within one component, as the Turkish example above illustrated for morphology, where the parameter biuniqueness conflicts with the parameter of optimal shape, both of which are morphological parameters.

Crucially, conflicts are constitutive and the *raison d'être* for the levels of naturalness below the system-independent level. Without these conflicts, there would not be a need for a typological level or for a system-dependent level that "filter" the universal level. To Fenk-Oczlon & Fenk (1995: 224), these levels are only "immunization strategies". In their proposal, they are futile. To illustrate this, Fenk-Oczlon & Fenk also discuss the Turkish example given by Dressler. Of a number of reservations,[58] the most pressing concerns the isolated nature of the label "unnaturalness" that is given to the shape of Turkish words. The most natural manifestation of optimal shape is stated in absolute terms in NM, i.e. everything that deviates from it is considered "unnatural". This evaluation is isolated in that it completely cuts out syntactic considerations. These, however, are crucial (as are phonological, etc. considerations) when language is seen as an "organized whole", since the morphological level does not function alone, but is interconnected with the other levels. Based on a larger comparative study by Fenk-Oczlon (1983), Fenk-Oczlon & Fenk (1995: 235) argue that Turkish words are natural *despite* being 'long' be-

[58] One of their most relevant and justified questions is *how* the most natural value on the parameter of "optimal shape" (as described in Section 1.3.2) was determined in NM in the first place.

cause the lengthening of words caused by affixes goes hand in hand with a "compensatory" reduction of words per sentence. The overall complexity, thus, is the same as for a language in which the words are not as long but the sentences are longer (cf. also Fenk-Oczlon 1998: 180). Both types of languages are "natural" in Fenk-Oczlon and Fenk's view. This also shifts the view from "conflict" to "cooperation", as it is argued – for this particular example – that morphology and syntax cooperate. If the burden is on morphology, syntax "supports" it in that it reduces its complexity. The complexity of the system as a whole, therefore, remains fairly stable. These ideas will be addressed again in Chapter 3 in the context of the systematic organization and the allocation of tasks within writing systems.

Whatever reservations about this level of naturalness might exist, the consensus is that typology is relevant, and we will see that for Natural Grapholinguistics, typology is indeed crucial, as it is this level at which Halliday's (1977/2010: 103, my emphasis) controversial claim "[…] a language usually got the *sort of writing system* it deserved" can be critically evaluated.

System-dependent naturalness. As Wurzel (1988: 111) states, NM would fail as a theory if it was to include only the system-independent level of naturalness, as this level cannot explain the question why morphological systems exhibit some unnatural traits, or, as Wheeler (1993: 100) formulates it: "how come real languages are so often 'unnatural'?" This is where the third subtheory, devised by Wurzel (1984), comes into play: *system-dependent naturalness.* It is based on the observation that what is natural system-independently or typologically can be filtered by the structural characteristics of a given language system: "It is not hard to understand that the consideration of 'normalcy' by a speaker depends on his/her linguistic experience, i.e. on the respective language-specific structural properties" (Wurzel 1987: 61). Inversely, the "lack of the typological and the language-specific system dependent filter leaves universal preferences intact" (Dressler 1999a: 142). In other words, the assumption of this level is motivated by the observation that the morphological naturalness of a language system not only depends on system-independent and typological naturalness, but – on the lowest and most imminent level – on language-specific as well as other extralinguistic factors. Here, 'extralinguistic factors' might seem too vague an expression, but in the context of writing, it will become clear that social and, most importantly, cultural factors play a role, as writing is not only shaped by our human physiology, cognition and socio-communicative needs (= system-independent naturalness) and the limited available possibilities of representing language with writing (= typological naturalness), but also by cultural traditions or other idiosyncrasies which can fundamentally shape a given script and/or writing system (= system-dependent naturalness).

How these different levels, including the yet unelaborated levels of norms and performance, as well as their respective subtheories can be transferred to Natural Grapholinguistics will be the subject of Section 3.1.2.

1.3.2 Scalar, evaluative *naturalness* and naturalness parameters

Nothing in the world is good or bad *an sich.*
(Vennemann 1988: 1, emphasis in original)

Unlike in NP, where *all* outputs of phonological processes are considered natural in an absolute sense (although some facets of NP contradict this), the semiotic and cognitive nature of NM suggests there must be various dimensions with respect to which naturalness can be determined, since the semiotic relation – in Peircean terms – between a *signatum* and a *signans* can be evaluated in more than one respect. Indeed, in NM, naturalness is treated as a gradual, evaluative notion (cf. Dressler & Kilani-Schoch 2016: 357). However, it is not instrumentalized to rank the absolute, that is, the *overall* naturalness of linguistic phenomena (both large phenomena such as whole languages, but also smaller phenomena such as words in a language), since these, as Vennemann's introductory quote implies, are not *inherently* ('an sich') good or bad. Instead, this overall naturalness of linguistic phenomena is always the approximate sum of a bundle of naturalness values on a number of relevant parameters.[59] A comparison of naturalness, thus, is only reasonable when done with respect to a specific parameter. And even then, naturalness on a given parameter is commonly not absolute, but a matter of degree. There is "no general agreement on the number" of these parameters, "nor is there a fixed list of semiotic principles […] from which parameters can be deduced" (Crocco Galèas 1998: 22). This conveniently leaves the door open for new parameters to be added by Natural Grapholinguistics. The central naturalness parameters elaborated in NM are presented below with demonstrative examples (for additional parameters and examples, see Crocco Galèas 1998). These examples are exclusively of morphological nature; for textual or pragmatic applications of these parameters, cf. Section 1.4, for grapholinguistic equivalents, cf. Section 3.1.2.3.

1) **Constructional iconicity** (sometimes also referred to as **diagrammaticity**, cf. Crocco Galèas 1998: 25-36): The semiotic principle motivating this parameter holds that a semantically marked category should correlate with an increase of substance in the *signans*, e.g. as in SG *boy*, PL *boy+s* (Wurzel 1994a: 2592). This example is a case of (I) *agglutinative affixation*, the most natural and maximally iconic form of constructional iconicity, as there is an increase of meaning in the signatum ('more than one boy') and an increase in the signans (the addition of the plural affix *-s*). The second degree of constructional iconicity is (II) *affixation and modification*, as in English SG *shelf*, PL *shelv+es*, where the affixation is accompanied by a (morphonological) modification of the base. Mere (III) *modification* is less natural and minimally iconic, for example in German SG *Vater* 'father', PL *Väter*. The next degree is non-iconic (IV) *metaphoricity*, exemplified by conversion or zero derivation as in *bottle* (the noun) and its derived verb *to bottle* or plural forms such as *fish* or *sheep* from SG *fish* and *sheep*. Less natural is (V) *total suppletion* as in English *good* and its comparative form *better*. Least natural in terms of constructional iconicity is counter-iconic (VI) *subtraction*: examples include the Franconian PL *hon* 'dogs', where the singular is *hond*, or German *Elternteil* 'parental unit', where the plural is the less complex *Eltern* 'parents' (cf. Dressler 1999a: 136; Wurzel 1994a: 2592; Crocco Galèas 1998: 32).
2) **Morphosemantic transparency**: A word is fully morphosemantically transparent if its meaning is fully compositional, i.e. if it equals the sum of the meanings of its constituent morphemes. The meaning of the inflectional form *bird+s*, for example, is comprised by the meaning of *bird* plus the meaning of plurality (cf. Dressler & Kilani-Schoch 2016: 363). For compounds, a word like *blue+berry* is more natural than *straw+berry*, because *blue* contributes more to the overall meaning of the word than *straw* (cf. Dressler 2006: 539).
3) **Morphotactic transparency**: This parameter concerns complex or inflected word forms. These are considered natural if their "constituents can be perceived without opacifying obstructions" (Dressler & Kilani-Schoch 2016: 364). Accordingly, a form such as *fife+s*, the plural of *fife*, is morphotactically more transparent than *wive+s*, plural of *wife*, because, in the latter, a morphonological rule has opacified the form of the singular base. In fact, this parameter of NM echoes the distinction made within NP in phonological processes and morphonological rules (cf. Section 1.2.2.1). The products of phonological processes, such as the homorganic assimilation of the prefix's consonant in *ir-regular* (where *in-* becomes *ir-*), are more natural according to morphotactic transparency than the products of morphonological rules such as *wive+s* or *knive+s*. Most unnatural according to this parameter is suppletion as in 1P *am* vs. 3P *is* or POS *good* vs. COMP *better*.

   Another aspect of this parameter that Dressler (1999a: 137) mentions and that is closely associated with the parameter of indexicality (see below) is the "preference for continuous (rather than discontinuous) morphs", meaning that prefixation and suffixation are pre-

[59] *Naturalness parameter* is just one of the terminological variants that have been used to label this concept of dimensions of naturalness. Alternatives include "naturalness principles, preference laws, marking conventions, principles of markedness" (Wurzel 1994a: 2591).

ferred to infixation, where a base is separated by an infix and is thus discontinuous, or circumfixation, where a base is surrounded by parts of a discontinuous affix.

4) **Biuniqueness**: The parameters of uniformity and transparency are subsumed under the heading of biuniqueness. If a sign relation is both uniform and transparent, meaning "one and the same form has always the same meaning and, vice versa, one and the same meaning is morphologically expressed only by one form" (Dressler & Kilani-Schoch 2016: 366), it is said to be biunique. Crocco Galèas (1998: 74) gives the example of Modern Greek prefix *is-* which signifies exclusively the meaning "movement towards or in a place" (= it is transparent); conversely, this meaning is only expressed by *is-* (= it is uniformly encoded), as in *aγoγí* 'instruction, education' → *is-aγoγí* 'introduction' or *pnoí* 'breath' → *is-pnoí* 'inhalation'. If a relation is only transparent but not uniform or only uniform but not transparent, it is not biunique, but only unique (s. the example of *-st* in German below).
   a) **Uniformity** (one function has only one form): In a paradigm that is characterized by uniformity, one function should be served by only one form. An example is the Latin term *amicus*, where /amik/ is preserved in all members of the paradigm (cf. Wurzel 1994a: 2592). Additional examples are the progressive aspect in English which is exclusively encoded by the gerund suffix *-ing* (cf. Crocco Galèas 1998: 66) or the superlative in German which is expressed by the suffix *-st*; note that the relation between *-st* and the superlative is uniform, but not transparent, since *-st* also encodes the 2P SG of verbs in German (cf. Dressler 1999a: 137).
   b) **Transparency** (one form has only one function): The use of the inverse parameter to uniformity demands that one marker/one form has only one function. A grammatical example is the German preterit *schlugen* 'they hit.PAST' as opposed to *schlügen* 'they would hit'. Here, the former transparently represents the indicative form of the verb, the latter the subjunctive (cf. Wurzel 1994a: 2592). Another example is the Italian inflectional suffix *-ss-* that expresses the imperfect subjunctive in all three conjugations, e.g. in *tem-e-ss-i* 'I worked' (cf. Crocco Galèas 1998: 70).

5) **Optimal shape/size of the signans**: This parameter is concerned with the optimal shape, or, in other words, the length of signantia. As words are seen as primary signs in NM (cf. Dressler 1987: 168), this particularly concerns the length of (complex) words. Semiotically, this parameter is motivated by the fact that signs are expected to be *distinctive* and *salient*, and length is assumed to play a crucial role in perception and retrieval processes. A bisyllabic foot – conforming to the parameter of binarity (see below) – was proclaimed in NM as the optimal form for a morphological word.[60] Affixes are preferably monosyllabic (cf. Dressler 1999a: 138; Dressler 2006: 540). However, as Dressler (1999a: 139) points out, "optimal shapes differ widely with the size of units of each component", meaning the understanding of what an optimal shape is can vary across the phonological, morphological, syntactic, etc. levels.

   Other accounts state optimal shape preferences a little less rigidly, claiming, for example, that "universal optimal word length seems to vary between one and three syllables" (Crocco Galèas 1998: 106), which again conforms to the extension of prosodic feet. It must be noted that this parameter interacts greatly with other parameters, such as biuniqueness. If words in a language consist of biunique morphemes, then complex words in which a lot of meaning or function – lexical as well as grammatical – is conveyed do not have an optimal shape. This is also the reason that words vary remarkably across different language types with regard to the parameter of optimal shape. Accordingly, as Dressler & Kilani-Schoch (2016: 367) remark, "typological differences are important": in inflecting and introflecting languages, words more easily conform to an ideal of optimal shape, while words in

60 Note that different statements have been made within NM concerning the optimal shape, as Dressler (1987: 169, my emphasis) states elsewhere that "*one syllable* is optimal for perception, computation and storage", rather than a bisyllabic foot.

agglutinating, incorporating, or polysynthetic languages are longer, and words in isolating languages are frequently monosyllabic, and thus, shorter than is considered most natural on the parameter of optimal shape. I want to remind the reader of the criticisms by Fenk-Oczlon & Fenk regarding not only, but most vocally this parameter of optimal shape, questioning, among other things, how its most natural manifestation was determined in the first place (cf. Section 1.3.1).

6) **Binarity**: Dressler proclaims this parameter based on his assumption that "binary morphological relations are preferred to ternary or *n*-ary ones" (Dressler 2006: 540). An example he gives is two-part compounds which are more preferred than compounds consisting of more than two elements: a compound such as German *Polizeiakademie* 'police academy' is thus more natural than the three-part compound *Kreditkartenrechnung* 'credit card statement', which can, like its English equivalent, be broken up into two members that, again, conform to the parameter of binarity: *Kreditkarte* 'credit card', itself a compound made up of two members (again binary), and *Rechnung* 'bill, statement'.

   Dressler (1999a: 138) mentions not only compounds in the context of binarity, but also grammatical relations, and claims that these are preferentially binary "based on the binary nature of neurological information transmittance". As already shown in structural linguistics, he remarks, even grammatical relations that are apparently ternary can be broken up into two binary relations. A three-part number system, with *singular*, *dual*, and *plural* as categories (as evidenced in Slovenian or Ancient Greek), can thus be reduced to a binary relation: *singular* vs. *non-singular* (subsuming *plural* and *dual*). This also implies that grammatical markedness relations (or naturalness scales) are primarily understood as binary: *masculine—feminine*, *present—non-present*, etc. (cf. Dressler & Kilani-Schoch 2016: 367).

7) **Indexicality**: Direct adjacency of affixes to their base is more highly preferred than a greater distance between affix and base (caused, for example, by intervening interfixes). An example is the Spanish diminutive *puebl-ito* 'little town', which is more natural than the alternative *puebl-ec-ito* 'small town' (cf. Dressler 1999a: 136).

8) **Figure—ground/foreground—background**: This parameter is primarily of perceptual nature, as it is claimed that in perception, what is needed is "distinct signs" in the form of "syntagmatic contrasts between a more important foreground or figure and a less important background" (Dressler & Kilani-Schoch 2016: 365). Examples in which the figure—ground distinction can be illustrated include compounds with a hierarchical relation between a head and a non-head: a *bookseller* is a type of *seller*. The latter, thus, is the head, and the more salient *figure* or *foreground*. By means of this example, the correlation between the different parameters can be illustrated: in *bookseller*, *seller* is the head both morphosemantically, as its grammatical features (animate, agentive) are transferred to the compound, and morphotactically, since, for example, the plural suffix attaches to it: it is *book+[seller+s]* and not **[book+s]+seller*.

In the course of Chapter 3, I will show if and *how* these parameters are relevant for Natural Grapholinguistics. I can anticipate that most of them play crucial roles in this new branch of Naturalness Theory (as I also preliminarily demonstrated in Meletis 2018). However, because writing as a system differs both from speech and, in certain respects, from language (even though it represents language), it is expected that in addition to these originally formulated parameters, new parameters specific to the domain of writing will be discovered.

1.3.3 'External' evidence

In NM, as should be the case in any other linguistic theory, evidence plays a crucial role, specifically for determining "markedness [or naturalness, D.M.] values" (Mayerthaler 1988: 3) on the parameters that were described in the previous section. Generative linguistics has been responsible for the categorization of different types of evidence, and the central distinction of importance for NM is the distinction between *internal evidence*, or "evidence derived from informant judgement" (Chomsky 1976: 12), and so-called *external evidence*, whose relevance was downplayed especially in generative linguistics.[61] In essence, external evidence was either considered unfit for mentalistic theories and thus ruled out *a priori* or deemed unnecessary since internal evidence was seen as sufficient (cf. Sinclair 1980: 94; also Singh 1988 for a defense of external evidence). In this context, Dressler (2002: 96) even speaks of an "aversion for using external evidence".[62] Linguists – including generativists – might not share a consensus of what 'external' refers to exactly,[63] but they typically agree that external evidence includes, but is not limited to, "evidence about phenomena such as speech production and perception, language acquisition, language change, speech pathology, etc." (Sinclair 1980: 94). Thus, it includes "first and foremost empirical data, which are able to provide arguments for the evaluation of linguistic models" (Schwarz-Friesel 2012: 659). As has been outlined in Section 1.2.5, external evidence already played a prominent role in NP (cf. Crocco Galèas 1998: 11; Dressler 1980: 76). In NM, however, its relevance was elevated to such a degree that made it debatable whether it is justified to continue calling it 'external' evidence – as also implied by the quotation marks in this section's title – or whether external evidence is instead simply *substantive evidence*.[64]

However, even within NM, the status of external evidence was a matter of debate and subject to changing opinions. What natural morphologists generally agree on is that "the locus of the linguistic explanandum is [...] not directly in linguistics" (Dressler 1999b: 394) and that, therefore, an interdisciplinary approach is necessary (cf. Dressler 1980: 76). In one of the inaugural works of NM, Mayerthaler (1981: 4f.) lists what he calls 'heuristic sources' for markedness (= unnaturalness) values. In this list, he separates the external sources from the internal sources. What is striking, now, is that these internal sources – by no means corresponding to what has been termed 'internal evidence' in generativism, which is basically grammaticality judgments and intuitions of speakers – are not explicitly mentioned in many other treatments of evidence in NM. It is not surprising, thus, that their status is negotiated across different contributions: in some works, external and internal evidence are deemed "as being of equal importance" (Dressler 2000: 289) since "all types of evidence are important" and "[a]dvocates of Natural Morphology do not subscribe to the dichotomy between 'necessary internal' evidence [...] and 'superfluous external' evidence" (Dressler et al. 1987: 12), whereas elsewhere, it is claimed that "external evidence is more important than internal evidence" (Dressler 1999b: 394). It might be true that in many analyses within the naturalist paradigm, more weight is assigned to external evidence. This, however, does not entail that internal evidence should be discarded or that its relevance should be downplayed similarly to how external evidence was/is treated in generative linguistics.

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[61] Cf. Botha (1979) and his *Nonnecessity*, *Nonprivileged Status* and *Nonconclusiveness Theses*, which showcase strategies of how external evidence was treated in early generativism; for a naturalist response to these, see Dressler (1986: 532f.).

[62] However, it was not seen as unnecessary by everyone, cf. Zwicky (1981: 603): "Where available and appropriate – in particular, where credible linking assumptions can be made explicit – external evidence should be brought to bear on analytic issues, in an attempt to make linguistic analysis compatible with (though not necessarily a subcase of) analysis in related fields".

[63] Schwarz-Friesel (2012: 659, emphasis in original) notes that *external* can have at least four different meanings: "first, external evidence is unconnected to language (but instead to conceptual world knowledge or the visual system, and thus, gives insight into cognition in general). Second, it does not stem from linguistics (but, for instance, from neuropsychology, but concerns language and the language faculty). Third, it is not acquired through introspection (but comes from the analysis of corpus data or experiments). And fourth, we even find a non-scientific version (which is not to be found articulated *expressis verbis*, but only applied in practical ways, meaning 'unbound to the premises of scientific approach'".

[64] Cf. Dressler (1986: 519), who mentions NM's "interest in substantive evidence (which is not 'external evidence' for NM)".

What Schwarz-Friesel (2012: 660) remarks for cognitive linguistics – that "[w]hat is needed is a combination of both introspectively gathered data and empirically based evidence" – also applies to Naturalness Theory. Also, not all types of evidence – whether internal or external – are relevant in the discovery of all naturalness parameters and their respective degrees/values, i.e. different types of evidence are necessary at different points or stages of different analyses. This also means that different types of evidence may be more or less relevant depending on the subtheory in question: while external evidence may be central in uncovering universal, system-independent naturalness values, system-dependent naturalness might rely more on internal evidence. Also, if external evidence is taken into account, it is paramount that there exists an adequate bridge theory between linguistics and the non-linguistic field from which the external evidence is taken (e.g. psychology or sociology). As Dressler et al. (1987: 13) hypothesize, the reluctance to use external evidence might stem from the fact that "such bridge theories are usually in a rather embryonic state".

In the following, the different types of external as well as internal evidence will be presented briefly; this presentation is based on Dressler et al. (1987: 12-14) and Mayerthaler (1981: 4-7, or in English: 1988: 3-5); cf. also Kilani-Schoch (1988: 46-50).

External sources:

1. *Evolution (phylogenesis)*: Phenomena that develop later in phylogenesis are less natural than phenomena that develop earlier.
2. *Maturation (ontogenesis)* and *language acquisition*: If a phenomenon is acquired earlier, it is more natural than a phenomenon that is acquired later. This applies to both L1 acquisition and L2 acquisition.[65]
3. *Perception*: According to NM, a phenomenon that is more natural is more easily perceived than a less natural phenomenon. For example, in a language with oral and nasalized vowels, the prediction is that there are more oral vowels due to "formant lowering in nasalized vowels which hampers discriminability and [due] to additional articulation activity" that is necessary in the production of nasalized vowels (Dressler et al. 1987: 13).
4. *Error linguistics* (in Dressler et al. 1987: 14)/*mistake linguistics* (in Mayerthaler 1988: 3): Slips of the tongue (or "of the pen", Dressler et al. 1987: 14) typically affect less natural phenomena. Note that following Corder (1967), I make a terminological distinction between *error* and *mistake* that is apparently not made in NM, as both terms are used interchangeably: an *error* is when an individual produces something incorrectly because he or she lacks the knowledge necessary to avoid the error – thus, it is unintentional and non-corrigible. A *mistake*, on the other hand, is when an individual produces something incorrectly although he or she knows what the correct form is, meaning "the form he or she selected was not the one intended" (cf. James [1998] 2013: 77). Consequently, mistakes are often corrected by the person who made them. Errors are subject of *competence*, mistakes of *performance*. Slips of the tongue, thus, are mistakes, not errors. However, both mistakes and errors will be relevant types of evidence for Natural Grapholinguistics.
5. *Speech/language disorders such as aphasia and disturbances*: Here, the prediction is that unnatural phenomena are lost or affected by disturbances before more natural phenomena.
6. *Baby talk*: Per Dressler et al. (1987: 14), "[a]dults prefer less marked elements when talking to children".

[65] Note that these first two types of evidence are often taken as justification for the claim that speech is more natural than writing. This will be reflected critically in Section 2.1.

Internal sources:

7. *Language change* and *chronology of change*:[66] Unnatural phenomena tend to change and become more natural phenomena. In addition, phenomena that are relatively more unnatural change *before* less unnatural phenomena (cf. also Section 1.3.4).
8. *Frequency* and *language typology*: Natural phenomena occur more frequently both in type and in token, that is, both as tokens within a given language system and as types across language types and the world's languages.
9. *Pidgins and creoles*: Unnatural phenomena are reduced in pidgins, and in creoles, it is natural phenomena that "recur first as newly introduced categories" (Dressler et al. 1987: 14).
10. *Analogy*: "In analogical changes less marked [= more natural, D.M.] forms survive better" (Dressler et al. 1987: 14).
11. *Neutralization*: When an unnatural and a natural phenomenon coincide in one form, it is typically the natural phenomenon that prevails and keeps the form, while the form of the unnatural phenomenon is changed.

Some additional types of external evidence listed by Zwicky (1973: 87f.) are language replacement, borrowing, cross-linguistic surveys of inventories, cross-linguistic surveys of processes, linguistic games, productivity of processes, poetic requirements, stylistic variation, patterns of dialect and idiolect variation, statistics of variation, patterns of exceptions, informant judgements of novel forms and, in general, psycholinguistic investigations of other types.

In Section 3.1.2.4, I will consider how some of these different types of external evidence can be used to uncover relevant naturalness parameters of scripts and writing systems. Most relevant in this context will be language (or in this case literacy) acquisition, errors and mistakes, disturbances of reading and writing, and script and writing system change.[67]

1.3.4 Language change

> It is certainly not due to chance that the works of adherents of Natural linguistics are either ignored or misunderstood. (Bertacca 2002: 15)

One of the most remarkable achievements of NM and of Naturalness Theory in general is that it can be used to explain and even predict certain facets of language change. This statement is certainly not to be misunderstood for 'it can explain *everything* about language change', which critics often conveniently seem to read into it. Since this is a such a central accomplishment, Naturalness Theory is sometimes referred to as (and in the process, reduced to) a theory of language change (cf. Elsen 2014: 176-179), although language change is just one domain in which it is 'put to use'. With that said, it is not surprising that this part of the theory is also the one most fervently attacked by critics (cf. Lass's piercing criticism in his book *On explaining language change*, cf. Lass 1980a). However, these criticisms often admittedly concern not exclusively Naturalness Theory, but theories of language change in general which maintain they can explain (anything about) it. Some aspects of the treatment of language change within Naturalness Theory are commonly omitted in criticisms. These, however, are instrumental in giving an accurate account that does not distort what the theory of natural language change actually holds. Adherents of this natural view of language change include many of the aforementioned

[66] Dressler (pers.comm., October 2017) remarks that he – and to his knowledge, all other natural morphologists – interpret language change or, more broadly, 'diachrony', as external evidence. However, both in Mayerthaler (1981: 4) and in Dressler et al. (1987: 14), language change is explicitly listed under 'internal sources'.

[67] In works in which only a subset of these types of external evidence is named, these four – language acquisition, mistake linguistics, speech disturbances, language change – are very likely among this subset (cf. Wurzel 1994b: 33f.).

naturalists (or sympathizers of the theory): Wurzel, Dressler, Mayerthaler, Stampe, and Vennemann (cf. Wurzel 1997: 295) – certainly to be included here is also Bailey. A comprehensive account of natural language change can be found in Wurzel (1994b).

The observation that underlies NM's claim that it can explain and partially predict language change is that language change is understood as a reduction of markedness (= unnaturalness), which equals an increase in naturalness. Per Wurzel (1994a: 2592), this understanding of language change was first formulated by Bailey (1973). The central tenets of *natural grammatical change* – which, as the name implies, focuses on grammar and does not treat the lexicon – are:

- It is (1) *grammatically initiated*, i.e. it is not initiated socially. As such, it cannot account for socially determined language change (cf. Wurzel 1997: 297), which is largely unpredictable (cf. Bertacca 2002: 4).
- It is (2) *local*, not global (cf. Mayerthaler 1987: 51; Bertacca 2002: 9): unnaturalness can be reduced only on one parameter at a time. Because of naturalness conflicts, this local unnaturalness reduction might give rise to the increase of unnaturalness on another parameter (or in another linguistic component, cf. Dressler 1980: 78; Stein 1989: 80). This feature of natural grammatical change steals much of those critics' thunder who find faults with the 'teleology' of Naturalness Theory (cf. Dotter 2005: 51). They ask "how, if a marked [= unnatural, D.M.] state is a kind of pathological state of a language to be in, these dispreferred states of the grammar arise in the first place" (cf. Stein 1989: 67). This question goes hand in hand with the common misconception that in Naturalness Theory, "synchronic states are assumed to be maximally natural" (Andersen 2008: 108). It is because of the locality of unnaturalness reduction that new unnaturalness can and *does* emerge in language systems, and therefore, logically, there cannot at any time be a maximally natural (in the sense of gradual naturalness) language system.[68]

  Consequently, such a maximally natural state can also not serve as the goal of language change (cf. Wurzel 1997: 298). In fact, although it is directed (see next point), language change does not have a global goal at all, just many small, local goals that are in conflict with one another. When a single of these goals is reached, simultaneously, on another parameter, the goal(s) will have receded into the distance.
- Language change is (3) *directed*, and the direction is 'unnaturalness reduction'. What has been misinterpreted regarding this feature is that Naturalness Theory claims to predict *if* and *when* language change will happen. This is untrue, as proponents of natural grammatical change posit exactly the opposite: predictions can exclusively concern the question of *where*, that is, pertaining to *which* unnatural grammatical phenomena language change can happen. If and when a particular change does happen, though, is a fundamentally social and, thus, unpredictable matter that cannot be captured by a grammatical theory (cf. Wurzel 1997: 297).

  Stein (1989: 83) defines this feature negatively when he states that "[…] if directionality can indeed be derived, it abolishes structures, rather than strives for 'beautiful' ones. This is why diachrony based on markedness establishes not teleologies, but finalities". Systems, thus, are not primarily made more natural – this is just an epiphenomenon of them being made less unnatural.
- Language change is interpreted as (4) *unconscious* and *unplanned* on the part of language users. They "do not avoid marked forms in order to change their language, but rather organize their communication economically and effectively and thereby change the language" (Wurzel 2001: 508f.). Accordingly, language change is only a byproduct of human actions.

68 Another source of unnaturalness in language systems is loans and borrowing, where unnatural structures are transferred from one language to another (cf. Dressler 1980: 79; Stein 1989: 81).

— However, it is both (5) *final* (and *not* teleological, see Stein's quote above) since the speakers' goal is to avoid unnatural grammatical phenomena, and (6) *causal* in that the reason behind language change is the behavior of language users (cf. Wurzel 1997: 298).
— An additional feature of natural grammatical change is that it is (7) *initiated by new generations*, i.e. children acquiring a language. In the course of L1 acquisition, they – unconsciously – attempt to avoid unnaturalness (cf. Wurzel 1997: 299; cf. Tamariz 2017: 400).

In sum, natural grammatical change can explain changes in a language's grammar when they happen (or have happened), and it can predict local changes based on (un)naturalness values, but it cannot predict *when* language change will happen. Also, it explains trends, not specific, individual instances of language change (cf. Bittner 1995: 121; Keller 2014: 162).

Another theory of language change that is relevant to Natural Grapholinguistics is Keller's *invisible hand theory*. For the formulation of this theory, Keller adapted Adam Smith's concept of the invisible hand for the domain of linguistics and operationalized it particularly for language change. Although Keller (1993; 2014: 155-167) has (albeit not scathingly) criticized Naturalness Theory,[69] Wurzel (1997) and Bittner (1995) have shown that invisible hand theory can, in fact, be reconciled with the theory of natural grammatical change as both share crucial commonalities that far outweigh the differences between them (cf. also Gaeta 2006: 18).[70] The following remarks are based on their comparisons.

The central tenet of language change – as invisible hand theory models it – is that single individuals can change language based on their communicative actions. Individuals choose linguistic resources that match their (communicative) goals. This choice is determined by certain factors that include the competence of the speaker, the speaker's expectations of the addressee's competence, social factors, situational factors, as well as biological factors (cf. Keller 2014: 128). Arguably the most important of these factors is the speaker's competence. It subsumes the knowledge of several guiding – or, following Grice – cooperative principles, so-called maxims: speak in an unambiguous way to avoid misunderstandings; speak as you would expect your addressee to speak if they were in your shoes; speak in a way that signifies that you are a member of a certain group (or not); avoid unnecessary effort and keep articulatory effort to a minimum; speak in a way that makes you socially successful but that requires minimal cost (cf. Keller 2014: 135-140). It is the latter maxim of economy (cf. Keller 2014: 142) that serves as an essential bridge to the naturalness parameters and their values that are crucial for explanation in natural grammatical change (cf. Bittner 1995: 116).

Following maxims by avoiding a certain word that might lead to a communicative misunderstanding is an individual's intentional action and indicates a change in his or her communicative behavior. Because the guiding principles are similar for everyone in a given language community, these changes in communicative behavior exhibit similarities across individuals and yield certain patterns. If enough people (consciously or unconsciously, but mostly the latter) choose to avoid a certain word in order to eliminate possible misunderstandings caused by it, this particular word may be eradicated from the language (for the illustrative example of how German *englisch* in the meaning of "angelic" was replaced by *engelhaft* because of it being homophonous with *englisch* in the sense of "English", cf. Keller 2014: 130f.). However, it is paramount to understand that it was not the speakers' intention to rid the language of this particular word, but rather to communicate successfully and effectively. Per invisible hand theory, language change is the byproduct of human actions, but it is not planned. Exactly the same applies to natural grammatical change as characterized above.

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[69] For a response to his criticisms, cf. Yevseyev (2003: 47f.).

[70] Even Keller (2014: 163-166) partially agrees that they are reconcilable in that he considers natural grammatical change – with a few clarifications that he makes – as an instance of change by invisible hand.

From this follows that language change according to invisible hand theory is

- (1) *pragmatically initiated*, meaning it serves to avoid pragmatically unsuitable linguistic phenomena.
- (2) *local* in that there is no overarching goal. As language change is caused by maxims and some of these maxims contradict each other or may be weighted differently for different individuals, it is difficult or impossible to predict in which 'direction' language change will lead in general.
- (3) *directed*, albeit in a different sense than just mentioned. The direction is not a pre-specified (ideal) state of a language, and the goal is also not unnaturalness reduction, but – as stated above – avoidance of pragmatically unsuitable linguistic phenomena.
- (4) *conscious*, at least at times, but simultaneously *unplanned*. *Conscious*, however, refers to the micro-level of individual actions and simply implies that in a given communicative situation, a speaker might consciously, for example, avoid a given word. What is conscious about this, thus, is the choice not to use a word, and not the language change that might or might not result from that choice in combination with similar choices from other speakers. Note that the choice not to use a word – and some might argue this is the default case – may also be *unconscious*. In that case, the speaker has the goal in mind – communicating efficiently in order to be socially successful – rather than the means to achieve this goal. Accordingly, speakers' individual actions are *final* as speakers have a result in mind, whereas the resulting change at the macro-level of the entire system is *causal* (cf. Keller 2014: 114).

  However, in each case, whether conscious or unconscious, choosing involves an evaluation: a speaker must decide whether a given linguistic element is pragmatically suited or not. To sum up, language change is unplanned as it is (maybe with very rare exceptions) not the speakers' intention to change their language.
- (5) *initiated by speakers in normal communication, i.e. predominantly by adult speakers*. It is imperative that speakers have already acquired knowledge of the maxims that are at the core of language change in invisible hand theory. Arguably, children who still acquire L1 do not have (sufficient) knowledge about these maxims yet, or they do, but only about a subset of them.

A comparison of this list of features with the list of features of natural grammatical change above reveals the vast overlap of these two theories of language change. In both theories, language change is directed but does not have a goal. Both theories interpret language change as causal, as man-made but unplanned, as local and not global; both are types of unintentional language change (cf. Bittner 1995: 117-120).

Important differences, on the other hand, concern the starting point of the theories: the theory of natural grammatical change aims to explain why there are certain tendencies of change that are rooted in the grammatical subsystems/components of language, whereas invisible hand theory attempts to explain how the communicative behavior of individual speakers determines language change. The domains of explanation also differ: while natural grammatical change is, as already emphasized, rooted in the system itself, especially the grammar, as Wurzel (1997: 302) remarks, the domain of invisible hand theory cannot as easily be delimited. Since it concerns mostly communicatively, i.e. pragmatically initiated change, invisible hand theory focuses on the lexical component of language. Consequently, natural grammatical change can be more reliably predicted than the lexical change that is the subject of invisible hand theory. As it is based on varying (un)naturalness values of linguistic phenomena, natural grammatical change can – locally – predict in which direction an instance of grammatical change will lead. Since language change in invisible hand theory is determined pragmatically, and different choices are not necessarily weighted according to their pragmatic suitability – or, if one wants to put it that way, their pragmatic 'naturalness' –, a certain instance of language change could always go either way. This means that, for example, there is no easy way to predict which of two words will be avoided in homonymy (but cf. Keller's *englisch/engelhaft*-example for the ecological conditions that help predict which of two homonyms will be avoided, cf. Keller 2014: 130).

Another difference involves the perpetrators of language change: in the case of natural grammatical change, these are predominantly children in the course of language acquisition, while for language change in invisible hand theory, initiators of change have to be aware of the communicative maxims, which means they are primarily adult speakers.

This comparison underlines that in many central respects, the two presented theories of language change are in agreement. The few relevant differences do not make them incompatible, as they only showcase that the theories are interested in different aspects of language change. Therefore, both of them will be relevant for the explanation of the change of scripts and writing systems.

A final remark regarding language change within Naturalness Theory concerns a seeming circularity: how can language change serve – as outlined in Section 1.3.3 – as evidence within Naturalness Theory that helps identify naturalness parameters and their values, and simultaneously be an application of the theory, claiming that Naturalness Theory can explain and predict certain facets of language change? When looking closely enough, these two aspects are not in conflict, and their compatibility is a matter of chronology: firstly, instances of past language change serve as heuristic indicators of which grammatical phenomena are particularly susceptible to change. Once these have been identified and – with the help of other types of evidence such as language acquisition and disturbed language – abstracted and systematically integrated into the theory in the form of naturalness parameters, it is precisely these naturalness parameters that can be used to predict further language change. In other words, Naturalness Theory aims to explain what has happened in the past, and based on this explanation, claims to be able to predict (part of) what might happen in the future.

1.4 Other subbranches of Naturalness Theory

Following the developments in NP and NM, the main tenets of Naturalness Theory were transferred to other linguistic components and adapted according to the respective characteristics and needs of these components. This section aims to present briefly the most prominent of these other naturalist approaches and the central principles that are expected to be relevant for Natural Grapholinguistics.

Dziubalska-Kołaczyk (2002a: 118) compiled a quite elaborate list of these 'other' naturalness approaches and their respective representatives.[71] Aside from phonology and morphology, the areas she takes into account are historical linguistics, first language acquisition, second language acquisition, phonostylistics, aphasia and related issues, psycholinguistics, metaphonology, sociophonetics, sociolinguistics, syntax, morphopragmatics, experimental phonetics, statistics, and text and discourse linguistics. In combination with the very detailed subject index in Luschützky's (1991: 61-67) bibliography, which includes mostly, but not exclusively, subjects that can be subsumed under phonology and morphology, this implies that the notion of naturalness spread remarkably from its initial roots in phonology and was consequently applied over a wide range of domains and phenomena. Many of these contributions, however, were of singular nature, as they did not manage to – or did not even attempt to – spawn full-fledged new subbranches of Naturalness Theory. Therefore, in the end, most of them represent interesting but ephemeral excursions into Naturalness Theory from 'the outside'. Yet, they often

[71] Dziubalska-Kołaczyk's (2002a: 118) phrases it more cautiously, stating that of the people she includes in this list, "some are advocates of naturalness, some eclectically admit naturalness as an interesting possibility, some became involved with it on some occasion, and, finally, there are those who sympathize with the framework, although they remain outside of it".

allow fruitful glimpses into ways how Naturalness Theory *could* be extended to account for linguistic phenomena not already treated in the theory.

Notably, some extensions of Naturalness Theory did manage to gain some amount of traction: these are *Natural Syntax* and *Natural Textlinguistics*, and they are dealt with in the next subsections. An additional – even if, as characterized above, singular – venture worth highlighting is *Natural Pragmatics* which, in essence, is outlined in merely one contribution: Kilani-Schoch, Sánchez Miret & Dressler (2011). Additional approaches that will not be described in this section but that will be mentioned elsewhere in this thesis, especially in the description of Natural Grapholinguistics, are *Natural Sociophonology* (cf. Dressler & Wodak 1982), *Natural Stylistics* (cf. Auer 1989), and the already mentioned *Natural Typology* (cf. Fenk-Oczlon & Fenk 1995; cf. Section 1.3.1).

1.4.1 Natural Syntax

The label *Natural Syntax* does not designate a single coherent approach to syntactic naturalness, but – to my knowledge – at least three different approaches: the one developed by Mayerthaler and colleagues in Klagenfurt (Mayerthaler & Fliedl 1993; Mayerthaler, Fliedl & Winkler 1998; Fliedl 1999), the model by Orešnik (2004, 2013) and colleagues, which Dotter (1994: 154) calls the 'Slovenian' model, and finally, the one by Haiman (1985). The latter was also the first to appear. Haiman's main contribution in this field, titled *Natural Syntax*, contains a single reference to works of Naturalness Theory, as it cites Stampe's dissertation on NP (cf. Section 1.2). However, it is startling that Haiman (1985: 174f.) cites Stampe in the context of *natural generative phonology* and does not specifically mention NP. In general, Haiman does not seem to consider his own work to be embedded in the global context of Naturalness Theory, which means the title that he chose for it is – in the context of the existence of NP and NM and their association with an overarching theoretical framework – misleading in that it implies Haiman's Natural Syntax is a branch of Naturalness Theory.[72] Unsurprisingly, it is sometimes interpreted this way by outsiders (cf. Joseph 2000: 197; Geeraerts 1999: 37).[73] However, the mere fact that in his approach, Haiman challenges the arbitrariness of language – and syntax in particular – by dealing with iconicity and diagrammaticity, and chooses to term the ensuing results *natural*, serves as independent evidence that some features of language are intuitively considered to be 'natural' also by linguists who do not subscribe to the larger theoretical enterprise that is Naturalness Theory.

Unlike Haiman's approach, Mayerthaler et al.'s and Orešnik et al.'s approaches are both explicitly positioned within the framework of Naturalness Theory. However, they differ in central aspects. The former is a generativistically oriented model of grammar involving constituent structures. Aside from the purely descriptive level, it includes an instrument of evaluation taken from Naturalness Theory that allows an assessment of the naturalness/markedness of syntagms and lexical entities (cf. Mayerthaler, Fliedl & Winkler 1998: 247; cf. also the evaluation of 'natural constituents' such as subjects and direct objects in Fliedl 1999: 55f.). In contrast, Orešnik (2013: 9) explicitly positions himself and the 'Slovenian' model of Natural Syntax against generativism as he acknowledges that the model follows "the approach usually called Naturalness, which arose as a reaction against the pervasive abstractness of generative grammars". His approach is a pseudodeductive approach. As he himself claims, it "does not perform

[72] De Cuypere & Willems (2008: 2) note, however, that Haiman's term *Natural Syntax* "did not catch on in the linguistic community".

[73] It is debatable whether Haiman's own assessment of his work – which was published before the heights of popularity of NM, but after the prominence of NP – or the fact that he himself did not integrate it into the framework of Naturalness Theory should be regarded as decisive in categorizing his work or whether, from a retrospective and outsider point of view, his approach is theoretically so congruent with Naturalness Theory that it *is*, in fact, justified to call it a subbranch.

as efficiently as generative grammars", but this is counterbalanced by the fact that his Natural Syntax operates with a much simpler apparatus. With his various analyses of specific linguistic phenomena (e.g. negation, dependent clauses, and interrogation main clauses in English; transitivity in ergative languages; etc.) he attempts to show that "Natural Syntax is capable of predicting a significant amount of language situations, given a small number of presuppositions (i.e., the particular description of language data adopted, the choice of variants, the naturalness scales, the alignment rules) and a modest apparatus (namely the deduction format)" (Orešnik 2009: 91).

Finally, in the context of Natural Syntax, there exist a number of more general contributions that do not present whole approaches but which discuss the question of how Naturalness Theory can be extended to syntax (cf. Sgall 1988; Stein 1988; Dotter 1990), as well as few applications of the theory in morphosyntactic analyses of specific linguistic phenomena (cf. Stein 1985, which deals also with natural syntactic change; Yevseyev 2003, which deals with aspectuality and taxis).

1.4.2 Natural Textlinguistics

Another noteworthy extension of Naturalness Theory is *Natural Textlinguistics*. It was first proposed by Dressler (1989), who outlined how the semiotic parameters of (1) iconicity, (2) indexicality, (3) transparency, and (4) figure—ground which had already been described in the context of NM (cf. Section 1.3.2) can be applied to the study of texts. In terms of its domain, Natural Textlinguistics stands in contrast to NP, as the latter deals with "the lowest pole of linguistic organization", while Natural Textlinguistics deals with the "highest pole, the one with the greatest number of variables" (Dressler 1996b: 295). This obviously results in vast differences between the approaches.

Examples of (1) *iconicity* on the text level include the diagrammaticity of *ordo naturalis*. This 'natural order' holds that the signans of a text must have a linear sequence. In spoken texts, this concerns the chronological sequence in which elements appear, while in written texts it also includes the spatial sequence of elements. This spatial arrangement is determined by the writing direction (left—right vs. right—left, top—down vs. bottom—up), which is conventionally (i.e., orthographically) agreed upon. *Ordo naturalis* – independent of the modality – is evidenced by sentences such as 'She shot him, and he died'. It contrasts with *ordo artificialis*, which – for the same proposition – would be 'He died after she shot him'. In the latter, the order of the elements in the signans is incongruent with the chronological order of the occurrence of the events in the signatum (cf. Dressler 1996b: 295). *Ordo naturalis* is not only found in narrative texts, but also in other genres, particularly descriptive and instructive texts such as recipes, directions, topography, and apartment listings (cf. Dressler 1989: 16f.).

Other forms of diagrammaticity on the text level include *climax* and *parallelism*. A climax in the signatum can, for example, be expressed in the signans by the increasing length of words or syllables. Dressler (1989: 18) illustrates this with the German example *Ich bin schön und du bist schöner und du die allerschönste*, 'I am beautiful and you are more beautiful and you the absolutely most beautiful'. Parallelism, on the other hand, is evident in examples such as German *Das tat ich für Dich. – Was tust Du für Mich?*, literally translated as 'This I did for you. – What do you do for me?' Here, the strength of the parallelism depends on the number of diagrammatic relations between the parallel strings in the signans and the signatum. In this case, the diagrammatic relations are 'this – what', 'I – you', 'for you – for me'. However, as Dressler (1989: 20) admits, from a theoretical standpoint, it is not easy to determine which of the sentences (the first or the second) is the signans and which the signatum. He claims, however, that perceptually, the parallelism is only constituted by the appearance of the second sentence. Therefore, it can only be recognized when the second sentence is received. Accordingly, Dressler suggests the second sentence, the one that appears later (chronologically and/or spatially) is the signans, whereas the first is the signatum.

(2) *Indexicality* is a parameter that is more prominent in texts than *iconicity*. In Peirce's (1965: II.369) own terms, an index is a sign "which like a pronoun demonstrative or relative, forces the attention to the particular object intended (= signatum) without describing it". The pronouns that he mentions are exophoric: for example, first-person *I* deictically refers to the speaker who utters it and thus to the extralinguistic realm. In contrast, endophoric indices refer to something that exists intratextually. Two types of endophoric indexicality are differentiated based on whether the signatum that the index refers to appears after the index (= anaphora) or before it (= cataphora). In the sequence of sentences *There was [a professor]$_i$ at our department. He$_i$ taught eleven classes*, the pronoun *he* in the second sentence refers anaphorically to the noun phrase *a professor* in the first sentence. For sequences of sentences that exhibit this structure, Dressler (1989: 23) claims that the noun phrase in the first sentence (here *a professor*) is – due to the use of the indefinite rather than the definite article – also "slightly" cataphoric because it gives the impression that something will be said later in the text about it, i.e. that it will be specified further. In terms of textual naturalness, for Dressler (1996b: 301; cf. also Fludernik 1996: 324), anaphora is clearly more natural than cataphora, since cataphoric indexicality refers to future and more or less "uncertain" referents, whereas anaphoric indexicality prototypically refers to explicitly produced antecedents that hearers can access in their memory or readers can simply look up in earlier portions of the text.

Another factor that Dressler (1989: 26-30) names as an evaluation measure for naturalness on the parameter of indexicality is the absence of an antecedent, which is less natural than the presence of an antecedent: in the sentence *Calling long distance is the next best thing to being there*, the word *there* does not have an explicit antecedent. Consequently, it must be inferred from *calling long distance* that *there* refers to a distant location. Yet another factor is the distance between an anaphoric/cataphoric device and the element it refers to within the text, with greater distance being more unnatural than closeness.

An important example for textual (3) *transparency* is pragmatic transparency which will, since it is central to *Natural Pragmatics*, be described in detail in Section 1.4.3.

The semiotic parameter of (4) *figure—ground* that was also already relevant in NM is motivated by gestalt psychology and refers to the fact that perception is alleviated if an object stands in stark contrast with its background. Interestingly, the majority of examples Dressler (1989: 48-49) offers for this parameter stem from written texts: footnotes, end notes, appendices, bibliographies – all of those refer to portions of texts that are less prominent than the main body and that are, therefore, (spatially) positioned less prominently than the main body. Accordingly, they represent the *ground* to the more salient *figure* (= main body). This also serves as a fitting example to highlight the interconnectedness of the parameters: when the existence of a footnote (= ground) is indicated in the main text (= figure) by the presence of, for example, a superscripted number, this number is a cataphoric signans that indexically refers to the footnote (= signatum). The footnote itself, on the other hand, anaphorically refers back to the portion of the text in which it was invoked by said superscripted number.

In a special issue of the journal *Language Typology and Universals* devoted to intercomponential parallelisms in Naturalness Theory, Dressler (1996b), as the founder and almost only prominent representative of Natural Textlinguistics (but see below) and a central figure in Naturalness Theory, restates some of the most relevant points of his 1989 monograph on Natural Textlinguistics and simultaneously underlines the parallels between the different components of Naturalness Theory. His contribution is followed by three reactions from Fludernik (1996), Petrič (1996), and Ritt (1996). Alongside additional textual examples for Dressler's parameters, these responses offer a number of interesting suggestions for a modification and/or further development of Natural Textlinguistics. The most relevant of those shall be mentioned here.

Fludernik (1996: 322) first comments on the fact that of the parameters Dressler mentions, only indexicality can claim cognitive naturalness. She justifies this by stating that unlike indexicality, iconicity is "most difficult to come by in real-life contexts and especially in texts". This is an interesting reservation about iconicity, as iconicity is claimed to be most natural in NM, which should be motivated by the fact that it is cognitively best processed. Fludernik's observation contradicts this. An example of textual iconicity that Fludernik indeed misses from Dressler's contribution is *quotation*, as she remarks that "[q]uotation of entire texts with in [sic] a frame text iconically represents the represented object – the text".

Furthermore, transparency, or biuniqueness (which subsumes transparency and uniformity, cf. Section 1.3.2), Fludernik claims, is only an ideal, a structural property of semiotic systems that is not prevalent. Dressler agrees on this point; in fact, he himself posits that "[t]he importance of biuniqueness is severely restricted in the languages of the world due to conflict with the principle of economy" (Dressler & Kilani-Schoch 2016: 366). Additionally, Fludernik remarks that biuniqueness is a relevant parameter mostly for 'small' linguistic units (such as morphemes) and "makes most sense in relation to a closed system" such as the morphological system, but "breaks down with open systems (the lexicon)" (Fludernik 1996: 325). This, too, dramatically reduces the significance of biuniqueness for textual analysis. In the context of the naturalness of writing, Fludernik's most interesting comments concern the relations between the materiality of writing and the textual level – and the lack of research covering this topic. For example, she argues that "paragraphing is an area of text analysis that needs to receive extensive attention in natural text linguistics" (Fludernik 1996: 325). Relevant questions in this respect are: Which linguistic units do paragraphs – defined as visual chunks of texts (cf. Section 2.2.1.2) – correspond with and how do writers decide when or where to start a new paragraph? These questions concern the graphetics–graphematics interface at whose core lies the study of how the visual substance of writing refers to, invokes or gives clues at the conceptual level about linguistic units or, more generally, linguistic information. In this vein, Fludernik (1996: 327) also demands more fine-grained textual categories such as the above-mentioned paragraph, but also the speech act, the argument, the narrative episode, etc.

One of the main points of Ritt's (1996) reaction echoes the debate described in detail in Section 1.2.3.2, namely whether phonological naturalness and naturalness at other linguistic levels – in this case, the textual – can be straightforwardly compared. Specifically, Ritt (1996: 320) asks "whether phonological and textual indexes are really comparable at all levels". It must be noted that his speaking of phonological indexes reveals that he *presupposes* that phonology can be treated within a semiotic framework, as was propagated by Dressler (1984) and rejected by, among others, Hurch & Nathan (1996). Ritt's question, thus, is already more fine-grained and concerns the comparability of phonology and other linguistic components *within* a semiotic framework. His conclusion is that phonological indices (he names, for example, anticipatory assimilations such as [ŋ] in English [ʌŋˈkæni] *uncanny*) and textual indices (such as anaphora or cataphora, see above) are not entirely comparable because the former are not "primarily intended" by speakers whereas the latter "are definitely employed with their indexical function in mind in the first place" (Ritt 1996: 320). This brings the discussion full circle, as it underlines that natural phonological processes are unconscious and phonetically motivated (possibly, these facts are causally related: they are unconscious *because* they are phonetically motivated), while natural phenomena at other linguistic levels are cognitively motivated and *can* (but do not have to) be conscious.

Despite this conclusion, Ritt (1996: 321) calls it a "beautiful thing" that "under the wider definition just proposed one gets a parallelism between phonological and textual indexicality exactly where one would expect it, and the apparent […] exceptionality of phonology would be greatly reduced". As I already argued in Section 1.2.3.2, this exceptionality of phonology is not a problem for Naturalness Theory. To the contrary, it enriches the theory, since not everything has to be explained cognitively, with explanation based on solely physiological terms also being permitted.

Dressler is not the only proponent of a Natural Textlinguistics. A different approach that is worth mentioning is Merlini Barbaresi's (2002, 2011). In a lot of respects, her approach parallels Dressler's. However, in some respects, it appears more elaborated and more explicit, partly because it integrates findings from other areas and theories. Merlini Barbaresi's (2011: 205) main assumption is that "any situation in the text that can be claimed to be less natural/more marked is a source of complexity, which in turn makes receivers' processing difficulty predictable". What this statement reveals is that for her, (un)naturalness/(un)markedness, complexity, and difficulty are distinct notions that are "logically independent" but "mutually correlated". In her understanding, complexity, as a cognitive state, is a bridge between (un)naturalness and difficulty.

An added value that her approach has for Naturalness Theory in general is that it explicitly transfers the concept of *Complex Systems* from other disciplines to Natural Textlinguistics; this is done in order to conceptualize the notion of complexity. What had been an implicit assumption for as long as naturalists have been working on Naturalness Theory (and probably, since Saussure) is that languages are complex systems. In these systems, complexity is 'emergent'. Texts are subsystems of language in which complexity "emerges as a consequence of marked linguistic and textual choices interplaying in the text. Its emergence is always motivated on some level of the text and can be explained and predicted" (Merlini Barbaresi 2011: 206). This interplay between choices and different (un)naturalness values leads to a "drift towards recovering balance and stability"; more elaborately phrased:

> In every complex system, subsystems may have different targets and requirements and these may conflict among themselves. In order to minimise damage to the entire system (and move away from chaos), the interacting subsystems need to abandon extreme competition and co-operate towards a compromise solution. Competition, that is, eventually produces a strong incentive towards co-operation and this allows interacting agents to reorganise themselves and mutually adjust towards common objectives and optimal efficiency. (Merlini Barbaresi 2011: 206f.)[74]

This frame of Complex Systems serves as a useful metaphor for Naturalness Theory in general. Also, it adds another layer to the predictability of language change according to Naturalness Theory (and invisible hand theory): if the local changes in the system create new unnaturalness, they, in turn, will warrant new, additional changes as reactions to this new-formed unnaturalness.

However, two limitations of this metaphor must be critically noted: while Naturalness Theory assumes that languages are complex systems, these systems do not have the capacity to change themselves – they are changed by their users. This means that it is not the parts (or *subsystems*, also called *agents* in the quote above) that reorganize themselves but the users that reorganize them. This is not to say that the structural features of the system do not facilitate or motivate the changes that users are responsible for. Yet, the system itself is not 'alive' like an organism in this sense, it is only alive in that it is used and subsequently changed in the course of this use. Secondly, this metaphor does not apply equally to whole languages as systems and to their components (e.g. phonology, texts) as the subsystems of these languages. Merlini Barbaresi (2002: 193) herself claims that "[i]f compared to the language system, text exhibits a more dynamic quality, due to the fact that its progression time is the diachronic span in which all complexity phenomena emerge while changes and readjustments occur". A text, thus, is a much more compact system which can be understood and analyzed much more coherently and comprehensively than entire language systems which are systems of immense complexity. Also, texts are most commonly closed systems in that – at the point of analysis – they are 'completed', i.e. they are no longer subject to change. A larger analysis of texts in general or textual practices is, of course, a more complex enterprise than the analysis of individual texts.

For Merlini Barbaresi, too, the most important parameters of textual naturalness are iconicity (especially its subform of diagrammaticity), indexicality, biuniqueness, and transparency (Merlini Barbaresi 2002: 197). In the context of textlinguistics, these must be evaluated with respect to the seven so-called standards of textuality: *text surface cohesion*, *conceptual coherence*, *informativity*, *text producer's intentionality*, *user's acceptability*, *situationality* (adequacy of the

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[74] This quote echoes Fenk-Oczlon & Fenk's (1995) view of 'cooperative linguistic components' which was described in Section 1.3.1.

text for a given situation) and *intertextuality* (in the sense of 'adherence to text type') (cf. Merlini Barbaresi 2002: 196).

1.4.3 Natural Pragmatics

A very promising glimpse into a prospective Natural Pragmatics is given by Kilani-Schoch, Sánchez Miret & Dressler (2011). The authors develop two naturalness scales of pragmatic inferences based on the parameters of *transparency* and *biuniqueness*.[75] These scales allow an evaluation of pragmatic complexity, which is defined as "a function of the number and types of inferences or inferential steps included in the description of an utterance meaning" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 237). This pragmatic complexity, similarly to what is claimed for other types of complexity in other subbranches of Naturalness Theory, is said to affect cognitive processing. A fundamental challenge, the authors remark, is "defining cognitive complexity of pragmatics and differentiating it from pragmatic complexity proper" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 239). Note that this is a problem that affects not only pragmatic naturalness but also naturalness in other linguistic components. We will see that in linguistic complexity research, these two different types of complexity are termed *absolute complexity* and *relative complexity*, respectively (cf. Section 1.5.3).

Regarding this question, the authors offer a number of clarifying statements that apply to Naturalness Theory as a whole: for them, "cognitive complexity appears as a function of the number of mental computations and neural processes executed by the brain for a given task and/or as a function of the qualitative nature of the computations and neural processes" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 240) – this, of course, does not apply exclusively to pragmatics, but any given linguistic task. They go on to emphasize that inferences, which are crucial for the evaluation of pragmatic complexity, are not real-time processes, and that there "is certainly no direct or simple connection between the scale of pragmatic complexity and the actual working of the brain" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 240).

Like other naturalist approaches, Natural Pragmatics takes into account external evidence. The authors admit, however, that there is a general lack of such evidence for pragmatics.

The first of the naturalness scales concerns *pragmatic transparency*, defined as "the ease with which an utterance meaning can be identified, i.e. its accessibility" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 242). On this scale, three values/grades of naturalness are differentiated: (I) optimal transparency which involves no flouting of maxims, (II) ellipsis, and (III) flouting of maxims.

Interpretations that are (I) **optimally transparent** can be "accessed relatively directly and without inferential work" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 243). However, the authors hold that there is *always* inferential work involved. If there are no other inferences involved, the minimal inference that a hearer needs to make in every case is that the speaker means precisely what he says. Examples for optimally transparent utterances are (I.1) *direct speech acts* such as orders stated as imperatives, cf. French *assieds-toi!* 'sit down!', or questions expressed as interrogatives, cf. *il fait mal ton bobo?* 'does your booboo hurt?'.[76] Less natural than direct speech acts are (I.2) *implicatures* in which the meaning of the utterances comprises what the speaker says directly, but only partially; an example is *Pierre and Marie went [together]*

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[75] As evidenced by these two scales, in some contexts, transparency is not only seen as a part of biuniqueness, but also as its own parameter (cf. also biuniqueness and the parameters of morphosemantic transparency and morphotactic transparency in Section 1.3.2). Kilani-Schoch, Sánchez Miret & Dressler (2011: 253) distinguish them as follows: "If transparency depends on the readiness to identify the linguistic components of a linguistic object, biuniqueness is related to the readiness to identify the relationships between meaning and form".

[76] All examples in this section are taken from Kilani-Schoch, Sánchez Miret & Dressler (2011).

to Salamanca. Here, the speaker does not flout any maxims by not explicating "together", since it is automatically included in a pragmatic (rather than strictly logical) interpretation of the sentence. Least natural in this first category of optimal transparency are (I.3) *standardized indirect speech acts*, such as a question like *Can you tell me a story?* that functions as a request.

A second grade of naturalness on the parameter of pragmatic transparency is (II) **ellipsis**. Here, Kilani-Schoch, Sánchez Miret & Dressler (2011: 247-249) distinguish between (II.1) *simple textual ellipsis* and (II.2) *complex textual ellipsis*. The former is displayed by an utterance such as *Pharmacie ouverte le jeudi* 'Pharmacy open on Thursdays' which is written on a sign in front of a pharmacy in francophone Switzerland. The intended meaning of this message is not comprehensible without the relevant sociocultural knowledge, in this case, that in the Swiss-French tradition, pharmacies remain closed on Thursdays. Given this context, the utterance is decodable; without it, its meaning is rather opaque and can easily be misread as 'Pharmacy *only* open on Thursdays'. In comparison, (II.2) *complex textual ellipsis*, in addition to the omission of pragmatic information, involves the omission of relevant syntactic information. In complex textual ellipses, contextual knowledge aids an understanding of the overall meaning, but may not be helpful in completely restoring the precise syntactic structure.

The third and least natural degree of pragmatic transparency is (III) *flouting of the maxims*. This category first subsumes (III.1) *flouting the maxim of relevance* which is evident in the simple exchange A: *Do you want some dessert?* to which B answers: *I am on a diet*. Here, A has to "determine how the utterance of B is related to his utterance by using sociocultural knowledge presumably shared with the interlocutor as well as logical reasoning" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 250). The category also includes (III.2) *non-standardized indirect speech acts* such as *I am cold,* where the intended meaning is the request *take me in your arms* (rather than, for example, *close the window*, which would be a more conventionalized signatum for this indirect request). Third and most unnatural is (III.3) *irony*, which flouts the maxim of quality. An example is a sentence such as *What a beautiful weather!* uttered when it is raining excessively. While the authors claim that "irony is clearly the most opaque phenomenon on our pragmatic scale" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 252), they acknowledge that a more fine-grained parametrization of irony would be necessary. It would include, for example, more degrees of opacity, and in this regard, the authors explicitly name as indicators of irony prosodic cues for speech and typographic cues for writing. Whether the latter are instrumental in the interpretation of written utterances is indeed an interesting and fruitful question that we will encounter again in Chapter 3.

The second scale of pragmatic naturalness is the scale of pragmatic *biuniqueness*. In line with how biuniqueness is treated in other naturalist approaches, in pragmatics, too, it "is related to the readiness to identify the relationships between meaning and form" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 253). Most natural is biuniqueness, whereas uniqueness/partial ambiguity (= transparency *or* uniformity only, cf. Section 1.3.2) is less natural, and non-uniqueness/multiple ambiguity is least natural. Corresponding with what has been said about biuniqueness for the other subbranches, the authors point out that instances of pragmatic biuniqueness "are scarce and can only be found in highly ritualized uses" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 253). This is due to the fact that most of the times, it is possible to rephrase a signans without it losing its meaning, i.e. the signatum is stable. An example of the rare instances of biuniqueness that the authors give is French *Je le jure* 'I swear to tell the truth', an utterance without any other meaning which simultaneously cannot be expressed differently without a rephrasing resulting in "severe perlocutionary consequences" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 254). Uniqueness is present in examples such as *Bonsoir* 'Good evening', a greeting that can be used in opening or closing sequences of conversations. It is uniform (= this greeting cannot be expressed by another form), but, because of its ambiguity as both an opening and a closing greeting, not transparent. The inverse relation is expressed by *Amen* and its alternative *Ainsi soit-il* 'So be it'. According to the authors, these forms do not differ in meaning, and individually, they do not have additional meanings to the one they convey (Kilani-Schoch, Sánchez Miret & Dressler 2011: 255). Thus, these forms are transparent, but because they both convey the same meaning, this meaning is not uniformly represented by one form. Lastly, there is non-uniqueness as in the example *Vous buvez?* 'Do you drink?' Here, the signans can have multiple signata, including 'would you like a drink?', 'are you drinking (right now)?', 'do you often drink?', and 'are you an alcoholic?' (Kilani-Schoch, Sánchez Miret & Dressler 2011: 256). These listed signata could also be expressed by different signantia that might or might not express the intended meaning more unambiguously and straightforwardly. Thus, this utterance is neither transparent nor is the relation between the signans and the signatum uniform.

An interesting point that the authors raise in their conclusion is that their scales of pragmatic naturalness are of perceptual nature in that they are scales seen from "the point of view of the interpreter" (Kilani-Schoch, Sánchez Miret & Dressler 2011: 259). In contrast, for a speaker, producing more explicit utterances is costlier than making use, for example, of indirect speech acts or elliptic utterances that are, in turn, not fully transparent for the hearer. Here, like on the lower level of phonology, we encounter the fundamental communicational conflict between the needs of the speaker vs. the needs of the hearer. In this context, the concepts of lenitions and fortitions can be fruitfully carried over from NP, although one has to carefully distinguish the levels of consciousness at which these processes operate at different linguistic levels. While phonologically, they are mostly unintentional and unconscious, it is likely that pragmatic lenitions and fortitions more frequently operate on a more intentional level.

1.5 Naturalness Theory and other related theories and concepts

As already mentioned in the introduction of this chapter, terminologically and conceptually, a number of other notions appear closely related to *naturalness* and have also been the subject of linguistic theorizing. Similar to the situation for *natural*, the adjectives referring to these notions also occur in colloquial everyday language: *marked, optimal, complex*. As is the case for *natural*, the meanings that these terms have in their respective linguistic theories do not straightforwardly correspond with their colloquial meanings. However, what all of these linguistic technical terms undeniably *do* share with their colloquial relatives and what they also have in common is that they invoke an evaluation. It seems that different linguists in different eras have strived to discover fitting ways (and with that, terms) for assessing the 'quality' of linguistic phenomena by means of comparing them.

In this section, I do not want to characterize Markedness Theory, Optimality Theory, linguistic complexity research and usage-based linguistics in detail. Instead, I highlight how they differ from Naturalness Theory in order to explicitly distinguish between the concepts of naturalness, markedness, optimality, and complexity. In other words: this section does not aim to thoroughly present related theories but to underline what Naturalness Theory is *not*.

1.5.1 Markedness Theory

The concept of markedness originated in the 1930s in the Prague School. Back then, it was not the cornerstone of its own theory, but a part of the larger structuralist paradigm. The two linguists most closely associated with it are Nikolai Trubetzkoy and Roman Jakobson (cf. Waugh 1982: 299; Waugh & Lafford 2006: 491).

Originally, markedness was a purely formal property (cf. Winter 1989: 103) that distinguished two linguistic phenomena. First formulated in the domain of phonology, Trubetzkoy identified three types of oppositions: in a (a) *privative* opposition, there is a 'marked' member (in the Russian original *priznakovyj*, in German *merkmalhaft*) that is characterized by the presence of a mark, and an 'unmarked' member (Russian *bezpriznakovyj*, German *merkmallos*)[77] in which that mark is absent (cf. Bybee 2010: 131f., 137; Andersen 1989: 22). In voiced vs. voiceless consonants, for example, the former are marked, the latter unmarked. In (b) *equipollent* oppositions, the members are equal (such as front vs. back vowels), and finally, (c) *gradual* oppositions are not binary since – as the name implies – there are various degrees (e.g., high vs. mid vs. low vowels). This is not the place to give a detailed account of the beginnings of the concept of markedness and what would become Markedness Theory, but it is nonetheless relevant to note that markedness was, at first, a structuralist concept formulated in the domain of phonology that allowed distinguishing between two linguistic elements. To preliminarily sum up, "[t]he core hypothesis of markedness theory pertains to correlations. The domain of the theory is in all cases pairs of opposing language-structural entities that exhibit an asymmetrical relationship in more than one respect" (Moravcsik & Wirth 1986: 3).

Jakobson continued working on and expanding this concept, but his work is characterized by an "[i]nconsequent treatment of markedness" (Gvozdanović 1989: 50). A crucial point for the broadening and, arguably, blurring of the concept came when Jakobson transferred it from phonology to grammar and the lexicon. One of the most famous early examples of Jakobson's application of markedness to grammar is the Russian correlation between *osël* 'donkey' and *oslíca* 'female donkey'. He observed that whereas *oslíca* can only signify a female donkey, *osël* is unmarked for gender. As Gvozdanović (1989: 53) critically remarks, however, "Jakobson apparently did not distinguish between meaning and interpretation at this point", a problem that afflicts also his later analyses of markedness phenomena (e.g. of the Russian verbal system). For a more detailed history of early markedness, including the problems and inconsistencies the concept faced, I refer the reader to Gvozdanović (1989), Waugh (1982), and Andersen (1989).

In an answer to a letter from Trubetzkoy, Jakobson responded that he regarded markedness as a fruitful concept with significance not only for linguistics but for ethnology and the history of culture as well (cf. Gvozdanović 1989: 52; Andersen 2008: 105; see Waugh 1982: 300f. for the relevant excerpts from both letters). Indeed, the concept has been applied productively to linguistic domains other than phonology (cf. Moravcsik & Wirth 1986: 5) as well as to non-linguistic domains (for examples, cf. Waugh 1982: 309-315). This stems from the view that markedness is considered "explanatory not just for language, but also for human behavior in general" (Waugh & Lafford 2006: 497). This point proves crucial for the comparison of Markedness Theory with Naturalness Theory. In this vein, Winter (1989: 103) notes that the "simple correlation of complexity and markedness was destroyed when an extension of the notion of markedness to a greater variety of domains of human language was introduced" as markedness "had ceased to be a strictly formal one and had become a functional notion".

The development described by Winter was propelled when Greenberg (1966) reinterpreted markedness in his typological approach, with a central modification of the theory being that the distribution of marked vs. unmarked members of correlations was taken into account (cf. Moravcsik & Wirth 1986: 3). This development had already been foreshadowed by the fact that, as Bybee (2010: 141) argues, Jakobson had "establishe[d] the human cognitive and physical make-up as the reference point for the unmarked". It was at this point that observations such as "children tend to learn first the unmarked category and only later the marked one [...]; in like fashion, aphasics lose first the marked category and only later the unmarked one" (Waugh & Lafford 2006: 493) entered the picture.[78]

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[77] Ironically, in these pairs of English and Russian terms, it is the respective word that signifies 'unmarked' that is marked: *bezpriznakovyj* is marked because of its prefix *bez-* 'without', *unmarked* is marked because of its prefix *un-*.

[78] Cf. Waugh & Lafford (2006: 493), who implicitly mention the conflation of Markedness Theory and Naturalness Theory: "Such observations have led some to assimilate the notion of markedness with that of normality or naturalness".

When considering the preceding subsections on Naturalness Theory, these last few lines should sound astonishingly familiar. In fact, this precise understanding of markedness was "transplanted from one metatheoretical paradigm to another" (Andersen 1989: 11) when naturalists took it up as the basis of Naturalness Theory, or more specifically, NM, the subbranch that directly builds on Jakobson's work. Thus, when Wurzel (1998: 65) writes that "markedness is nothing but straining of the human language capacity, conditioned by the articulatory-auditive, semiotic and cognitive complexity of the respective grammatical entities", we witness a shift from Markedness Theory to Naturalness Theory. Note that when naturalness is interpreted as the opposite of markedness (and as a synonym of 'unmarkedness'), the respective concepts of markedness in Naturalness Theory and in (later) Markedness Theory are very similar. An essential difference concerns the perspective: whereas "[m]arkedness defines not what it wants but what it does not want" (Stein 1989: 84), I argue that naturalness, in contrast, defines not what it does not want but what it wants. Accordingly, the central difference is not a conceptual one, but one of terminological choice, a matter of scientific sociology: if you identify as a naturalist and position yourself within Naturalness Theory, you will use "(un)natural", if you identify as a proponent of Markedness Theory, you will use "(un)marked".

The preceding paragraphs have given the impression that there is such a thing as a homogenous "Markedness Theory". There is not. As Waugh & Lafford (2006: 497) note, there are "linguists who feel that the original definition of markedness has been stretched so far as to be an unwieldly cover term for very different phenomena, especially since its definition changes across different theoretical traditions". One of these linguists, arguably the most vocal one, is Martin Haspelmath. In a 2006 article with the programmatic title *Against markedness (and what to replace it with)*, he argues not against the tenets of Markedness Theory, but against the concept of markedness, which "became established as an almost theory-neutral everyday term in linguistics" (Haspelmath 2006: 27). In the article, he describes a remarkable twelve different senses of the term which can be subsumed by four larger classes: markedness as (1) complexity, as (2) difficulty, as (3) abnormality, and as a (4) multidimensional correlation (cf. Haspelmath 2006: 25).

Of these, early, formally-defined markedness mostly corresponds with "markedness as complexity", whereas later, functionally-oriented markedness corresponds with "markedness as abnormality". Markedness in the sense that was taken up by Naturalness Theory is best captured by "markedness as difficulty". At this point, I do not want to argue that Haspelmath is not right, nor do I want to comment on his reservations about the term markedness in detail, but I do want to point out that the problem of scholars not carefully defining the terms and concepts they use is not exclusive to markedness. As we will see, another term that is afflicted by this problem on a grand scale is *grapheme* (cf. Section 2.2.2.1). Ultimately, the same can be argued for both markedness and the grapheme: the fact that there circulate many different meanings for these terms is not a sufficient reason to abandon them altogether, as long as there is (or could be) even one adequate context in which they are defined properly and used according to this definition. The terms themselves are not the problem – not defining them in specific contexts in which they are used is.

Even though, for reasons stated above, "in casual usage the words *naturalness* [...] and *markedness* [...] may be practically synonymous" (Andersen 2008: 101, emphasis in original), it is, despite their remarkable overlap, paramount to still acknowledge that they "are technical terms which have precise meaning within their respective theories" (Andersen 2008: 102). Thus, while 'later' functional markedness is conceptually close to naturalness, Andersen attempts a comparison between early, formal Markedness Theory[79] and Naturalness Theory to highlight the differences between them.

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[79] Actually, he treats a modern, modified version of this early formal Markedness Theory in which the inconsistencies of the earlier theory are/have been dealt with.

First, he notes that the two concepts have different origins: referring to NP rather than NM, he observes that naturalness originated "in a fairly concrete approach to phonology" (Andersen 2008: 105), whereas markedness was – before Trubetzkoy and Jakobson took it up – first observed by the philosopher and ethnologist Lucien Lévy-Bruhl in the context of cultural rituals. This explains that Jakobson would recognize the importance of the concept in contexts other than linguistics, as markedness originated in these non-linguistic contexts.

The second and major difference that Andersen identifies is that while naturalness works with scales, markedness works with relations, a point at which Andersen's comparison of the concepts turns into a critique of naturalness. The basis for his criticism is the fact that markedness relations are asymmetrical, non-scalar or scalar, exclusive as well as inclusive (cf. Andersen 2008: 104; see also the three types of oppositions at the beginning of this section) and the marked term can be substituted by its unmarked counterpart, whereas, in contrast, naturalness relations are all scalar (hence, Andersen speaks of naturalness *scales*), logically exclusive, and symmetrical. These features of naturalness relations result in a number of shortcomings, Andersen argues, among them the following:

> Naturalness theory's odd idea that all linguistic relations are scales makes it impossible for the linguist who applies this theory to attain descriptive adequacy in the face of the actual variety of, say, semantic relations. (Andersen 2008: 116)
>
> By denying the existence of asymmetric relations – which include hyponymy – Naturalness theory is unable to describe the typical dynamic relation between incoming and outgoing synchronic variants, let alone the dynamic relation of substitution without which no variation could arise or eventuate in change. (Andersen 2008: 117)

The core of these criticisms holds that Naturalness Theory cannot adequately treat synchronic variation, which is part of the reason why it, such is Andersen's claim, cannot adequately describe and explain language change the way Markedness Theory can. In fact, Andersen's criticism boils down to the fact that Naturalness Theory is but a part of Markedness Theory, which he explicitly claims: "Markedness theory in essential respects subsumes Naturalness theory" (Andersen 2008: 101). This, again, has to do with markedness relations, which he believes subsume naturalness scales. He argues that Naturalness Theory claims linguistic relations are asymmetrical: a linguistic element that is considered *more natural* is positioned higher on a naturalness scale than a linguistic element that is *less natural*. Andersen contends that if *more natural—less natural* is a scalar, contrary relation (a *gradual opposition* in Trubetzkoy's terms), it is not asymmetrical, but logically symmetrical. Asymmetry, however, is central to oppositions and necessary to explain the possibility of substitution that is also vital for language change:

> This is where Markedness theory provides a superior conceptual tool, for asymmetry is inherent in the relation of inclusion, and the cognitive primacy of inclusion entails a principled explanation of the observed fact that asymmetrical values are ascribed also to exclusive relations in language. (Andersen 2008: 116)

Different types of observable relations in language, including contradictory relations such as *male* vs. *female*, converse relations such as *parent* vs. *child*, and antipodal relations such as *south* vs. *north* can be accommodated by naturalness scales even though there are no apparent steps on the scale between the poles. Andersen claims that "[t]he reason for this is that all such relations can be conceptualized as varieties of contraries with virtual (unrealized) intermediate areas or steps" (Andersen 2008: 115). Finally, this leads to Andersen's (2008: 115) conclusion:

> Since nothing prevents degrees of markedness from being ascribed to entities on a scale, and markedness values can be ascribed to contradictory and converse opposites as well, it follows that markedness is a more general concept than naturalness. It subsumes it.

It must be noted that Andersen's remarks pertain solely to the structural, that is, the semiotic level, what I have called *qualitative naturalness* (cf. Section 1.1).[80] In this respect, Andersen's

[80] Also, Andersen's criticisms pertain to a specific application of Naturalness Theory, the Slovenian model by Orešnik and colleagues (cf. Section 1.4.1), and here, he criticizes mainly the fit of this model for

criticisms are viable and valuable as they point to some possible blind spots of Naturalness Theory. However, qualitative naturalness is only one – albeit a central – part of Naturalness Theory. The naturalist strives not primarily for this descriptive qualitative naturalness, but the deductive and explanatory processing naturalness that results from a consideration of a myriad of evidence. While qualitative naturalness might not be as fine-grained as the type of markedness that Andersen describes, processing naturalness will point directly to the relevant points on a naturalness scale, even if a previous description of qualitative naturalness did not enclose them. In any case, Andersen's valid points of criticism will definitely be considered in describing an adequate theoretical framework for Natural Grapholinguistics.

1.5.2 Optimality Theory

Another theory that is frequently associated with Naturalness Theory, particularly NP, is Optimality Theory (for overviews of the theory, cf. Archangeli & Langendoen 1997; Kager 1999; McCarthy 2002). Aside from its similarities with Naturalness Theory, what makes it worth discussing is the fact that a number of grapholinguistic analyses have been treated within the paradigm of Optimality Theory (cf. Geilfuß-Wolfgang 2002; Primus 2004; 2007; Wiese 2004; Song & Wiese 2010; Baroni 2013).

Sprung from generativism, Optimality Theory is an "extremely simple formal model of language" (Archangeli 2006: 553) that was introduced in the early 1990s. Naturalness Theory and Optimality Theory differ most sharply in that the former is a functional theory, while the latter is a formal theory. However, as we have seen in Section 1.2.4, this does not automatically imply that the two theories are incompatible, and indeed, the picture is not quite so simple. As Tobin (2009: 171f.) mentions in a comparison of NP and Optimality Theory, NP is not necessarily 'not formal' while Optimality Theory "seems to have created a marriage combining functionalism and formalism". For this reason, it is not entirely surprising that the two theories share important commonalities.

While Markedness Theory gave important impetus to the formation of parts of Naturalness Theory, Optimality Theory developed later than Naturalness Theory and was, arguably, influenced by it despite being rooted in the generativism that NP rejected (cf. De Cuypere & Willems 2008: 2). Proponents of Optimality Theory rarely give credit to these earlier influences (cf. Bybee 2010: 138).[81] Indeed, as Donegan & Stampe (2009: 22) critically note, some developments within Optimality Theory that were proclaimed as new had already been formulated in NP:

> The foundation of Optimality Theory is the idea that phonology is a system of universal phonetic constraints that a speaker brings to a language, rather than a system of rules that a learner must induce from the observation of surface forms. This is an important break from the position of structural and generative phonology, but it is one that Natural Phonology made long ago.

As this quote already implies, Optimality Theory was first formulated for the domain of phonology and later, like Naturalness Theory, extended to account for, among others, syntactic (cf. Wunderlich 2006), morphological (cf. McCarthy 2006), and pragmatic (cf. Zeevat 2006) questions as well (cf. Archangeli 1999: 532).

Archangeli (2006: 554) posits that the "architecture of optimality theory is deceptively simple". Central is the assumption of universal and violable constraints that mediate between

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the analysis of semantic naturalness. Semantics, however, was never the focus of any approach in the naturalist framework.

[81] This does not mean they never do, however: as Hurch (1998: 116) notices, it was in the paradigm of Optimality Theory that generativists for the first time favorably mentioned Naturalness Theory. Prince & Smolensky (1993: 2), for example, note in one of the first works on Optimality Theory that the "work of Stampe [...], though framed in a very different way, shares central abstract commitments with our own".

the input and the output. There are two types of these constraints: (1) faithfulness constraints and (2) markedness (or wellformedness) constraints. Faithfulness constraints evaluate how closely an input corresponds with an output. A match between the input /abc/ and the output [abc] would be maximally faithful and would violate no faithfulness constraints. Markedness constraints, on the other hand, solely evaluate the output and how well it suits the structures of a language, whether this concerns phonotactics and syllable structure, word structure, or other structures of a language. These constraints are all universal, but they are hierarchically ranked, and it is this ranking that is variable and language-specific. In a given ranking, violations of lower-ranked constraints are more tolerable than violations of higher-ranked constraints.

A principle termed "richness of the base" holds that there are no limitations to the input, and that "the set of *inputs* to the grammars of the languages is the same" (Smolensky 1996, emphasis in original). Only two operations are at work in Optimality Theory: GEN (Generator) assembles the set of output candidates (CAND$_1$, CAND$_2$, ... CAND$_n$), and EVAL (Evaluation) selects the optimal candidate. It does that by evaluating which candidate best conforms to the given ranking of constraints. Figure 4 gives an overview of the structure of the theory.

Optimal, thus, is an attribute ascribed to the candidate that best conforms to the constraints, i.e. the candidate that does not violate the higher/highest-ranked constraints which have top priority in a given language. On a superficial level, the crucial terminological difference between *optimal* and *natural* is, as for *marked* and *unnatural*, caused by the embedding in different theoretical frameworks and scholarly traditions. A deeper analysis reveals parallels which are less trivial: what is natural is evaluated with the help of natural processes or naturalness parameters, whereas what is optimal is evaluated with respect to constraints. This raises the question of how processes and parameters differ from constraints, a question that I will attend to below.

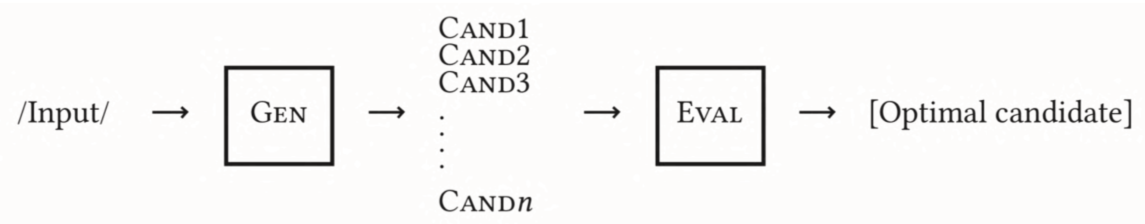

Figure 4: Structure of Optimality Theory, from Archangeli (2006: 554)

A first important commonality is that constraints, like natural phonological processes, are universal. Thus, "both NP and OT [= Optimality Theory] require that phonology should be capable of making correct predictions about any attempted utterance and do not limit themselves to the lexicon of the language under description" (Tobin 2009: 171). Also, both processes and constraints are assumed to be innate. The latter is, by the way, one of the respects in which Optimality Theory "does break with the generative (Chomsky-Halle) paradigm, which assumes that all phonological alternations are learned" (Tobin 2009: 172).

The similarities do not stop there: as Donegan & Stampe (2009: 22) note, markedness constraints in Optimality Theory "refer to the same phonetic difficulties as natural phonological processes do". Additionally, the fact that these constraints can be violated echoes the fact that natural processes can be suppressed. By contrast, faithfulness constraints are reminiscent of inhibitions of natural processes: in both cases, the goal is to have the input survive rather unscathed.

The ranking of constraints is similar to the weighting of naturalness parameters in NM. Some languages (or language types) favor some parameters such as biuniqueness over others such as optimal shape, which are sacrificed or, in Optimality theoretical terminology, 'violated'. In naturalist terms, naturalness parameters stand in conflict with each other, whereas in Optimality theoretical terms, biuniqueness ranks higher than optimal shape. From this follows that implicitly, the two levels of system-independent naturalness and system-dependent naturalness are accounted for in Optimality Theory: the constraints are system-independent, the ranking system-dependent. Additionally, one can discover similar rankings in languages of the same type, which would neatly correspond with the level of typological naturalness. However, a crucial difference is that in Optimality Theory, the ranking of constraints is made explicit, whereas "NL [Natural Linguistics, D.M.] provides as yet no equally explicit, principled and straightforward mechanism for describing how such [naturalness, D.M.] conflicts get resolved" (Ritt 2001: 306).

Another striking difference between NP and Optimality Theory is that the latter, "like its generative forebears, attempts to deal with morphonological alternations using the same phonetically-based constraints as those that govern phonology" (Donegan & Stampe 2009: 24). In sharp contrast, NP conceptually distinguishes between natural phonological processes and morphonological rules (cf. Section 1.2.2.1). Also, the theories treat differently the question of what can serve as input: as already mentioned, Optimality Theory, motivated by the assumed "richness of the base", permits all kinds of inputs. NP, on the other hand, limits lexical forms; these limitations "reflect language-specific limitations on speakers' perceptions" (Donegan & Stampe 2009: 24).

Two further differences between Optimality Theory and NP need to be mentioned. The first of them concerns perception, which is treated separately in NP and not at all in Optimality Theory. If the latter does mention it at all, it is assumed "that perception is entirely faithful to the phonetic output" (Donegan & Stampe 2009: 24). In NP, processes affect perception insofar as fortitions limit the inventory of sounds that hearers can categorize while lenitions allow hearers to identify which sounds are not part of the inventory as they are just variants of the sounds that are. The second difference is the application of constraints and processes, respectively. While constraints apply simultaneously, process application is ordered: fortitions apply first (and simultaneously), and then lenitions apply. Lenitions can also iterate in some cases. On this basis, NP can account for opacity resulting from counterfeeding, which poses a problem for Optimality Theory.

Explanation is dependent on constraints in Optimality Theory and on parameters in NM and other subbranches of Naturalness Theory, which is why I want to compare them a little bit more (for a more detailed comparison, cf. Ritt 2001). Constraints are "inductive generalizations, while preferences[82] are deductive inferences" (Dziubalska-Kołaczyk 2002a: 120). While Optimality Theory exhibits paradigm-internal differences from other generative approaches (cf. Tobin 2009: 171), the disregard for 'external' evidence is maintained, which means the constraints are not grounded in evidence. As Joseph (2000: 200) puts it, Optimality Theory is basically "a matter of determining plausible constraints, hopefully ones that are not ad hoc or language specific, and ordering them so as to come out with the desired answer". These remarks imply that there is a danger the constraints might be ad hoc, and they also insinuate that rankings can be idiosyncratic since linguists decide on them, sometimes possibly in a way that best suits their analysis.

A vast difference between Naturalness Theory and Optimality Theory is that the latter "has never made a specific case for psychological reality" (Nathan & Winters 2001: 352). For this reason, "questions where constraints might reside in human brains and how or why they might get there are not felt to be particularly urgent" (Ritt 2001: 305). Similarly, Naturalness Theory also does not aim to locate preferences for certain parameters (or even the relevance of these parameters) in the brain. It does, however, aim for psychological (and physiological) reality in that it establishes the physiological or cognitive foundations for processes and parameters.

[82] Dziubalska-Kołaczyk uses the term *preferences* (and so does Ritt 2001) where I use *parameters* instead. Indeed, my terminology is less precise: what is comparable to constraints in Optimality Theory is indeed preferences – preferences *on the different parameters*, e.g. the *preference* for the most natural value *on the parameter of* biuniqueness. 'Parameter', thus, is a terminological shortcut that highlights the different categories of preferences.

This, I argue, is probably the most pressing difference between the two theories. Thus, while some grapholinguistic contributions positioned within Optimality Theory (some of them cited above) *describe* constraints, I strive to *explain* them. As I have stated in the introduction of this thesis, the time has come to shift the focus from description to explanation. For this very purpose, Naturalness Theory serves as a useful and potent tool.

1.5.3 Linguistic complexity

The terms *complex* and *complexity*, similarly to *natural* and *naturalness*, seem to defy a coherent definition and operationalization (cf. Fischer 2017: 19). Accordingly, what should be noted right away is that there does not exist *one* binding definition for these terms that is used consistently in linguistics. In this section, I do not aim to propose such a definition, but instead give a glimpse of what has been discussed in linguistic complexity research and showcase how some of this work relates to Naturalness Theory.[83]

Complexity is understood as a gradual concept, much like naturalness in the majority of naturalist approaches, such that phenomenon x can be more or less complex than phenomenon y. Complexity can only be evaluated through description: in what is called *Kolmogorov complexity*, x is more complex than y if the shortest description of x is longer than the shortest description of y (cf. Fischer 2017: 21). While this type of complexity concerns the complexity of a phenomenon itself (through its description, that is), description can also pertain to the regularities of compared phenomena: so-called *Gell-Mann complexity* states that x is more complex than y if the shortest description of the regularities or structured patterns of x is longer than the shortest description of the regularities or structured patterns of y (cf. Fischer 2017: 22).

As Fischer (2017: 19) remarks, it is a seemingly hopeless enterprise to evaluate the complexity of whole systems, for example whole languages. Complexity of this type is termed *global complexity* (cf. Miestamo 2008; Szmrecsanyi & Kortmann 2012: 8-10). An idea that is indirectly related to this claim as well as to the notion of languages as self-organizing organisms (cf. Fenk-Oczlon's view in Section 1.3.1) is that all languages are equally complex. This view, which has been termed the *ALEC statement* (*A*ll *L*anguages are *E*qually *C*omplex) or the *linguistic equi-complexity dogma*, has come under serious scrutiny at the beginning of the 20th century (cf. Nichols 2009: 110; Szmrecsanyi & Kortmann 2012: 6-8). Developments that led to a critical reevaluation of this dogma include McWhorter's (2001) claim that there are indeed languages that are less complex than other languages, namely creoles. This represents a reckoning of sorts with the view that there is a trade-off between the *local complexities* (as opposed to global complexity) of the subsystems (phonology, morphology, syntax, semantics, lexicon, pragmatics) of a self-organizing language that results in equal global complexities for all languages. As Szmrecsanyi & Kortmann (2012: 9) write:

> Some studies have suggested that high levels of local complexity in some domain of a given language do not necessarily entail low complexity in some other domain of that same language, as the equi-complexity dogma [and the concept of languages as self-organizing systems, D.M.] would predict.

The thought of the global naturalness of entire languages (or comparable systems) has not been pondered as explicitly in Naturalness Theory, but it is worth (re-)assessing in the context of the proposed Natural Grapholinguistics: can some writing systems – in their entirety – be more natural than other writing systems?

[83] Interestingly, in a review of linguistic complexity, Szmrecsanyi & Kortmann (2012: 10) explicitly mention morphological naturalness (with a reference to Mayerthaler 1981) in the context of listing "[o]ther complexity/simplicity measures that have been proposed but not explored extensively". The latter part of this statement appears odd since morphological naturalness *has* been explored quite extensively. Ultimately, this example might be symptomatic of a missed chance of a fruitful dialogue between theories/approaches.

Nichols (2009: 111) remarks that "[m]easuring the total complexity of a language in cross-linguistically comparable and quantifiable terms would be a massive task and unreasonably costly in time and effort". Here, she speaks of *absolute complexity* rather than *relative complexity* (see below) in that she includes only linguistic complexity (= grammar and lexicon) and excludes "complexity (or difficulty) of processing, mental storage and management, learning, etc." (Nichols 2009: 111). Although it is a "massive task", Nichols does not believe it is an impossible task, and neither do I. What is a necessary prerequisite to achieve this task is "a properly comprehensive definition of complexity" that "should make it possible to draw a representative sample of complexity in enough different grammatical domains, relatively easy to survey, to give a reliable indication of whether overall complexity does or does not vary" (Nichols 2009: 111). Four factors that she includes are relevant for Naturalness Theory as well: (1) the number of elements a grammatical subsystem (phonology, morphology, etc.) contains; (2) the number of paradigmatic variants of these elements of the grammatical subsystem; (3) syntagmatic phenomena/dependencies such as agreement, valence, etc.; finally, (4) constraints on "elements, alloforms, and syntagmatic dependencies, including constraints on their combination" (Nichols 2009: 112). Nichols' proposal already touches upon the probably most relevant subcategorization of complexity that echoes a crucial subcategorization in Naturalness Theory.

This categorical distinction is most commonly known as Miestamo (2009) formulated it: *absolute complexity* vs. *relative complexity*. Absolute complexity is an objective, theory-oriented measure, and relative complexity is a user-oriented, subjective measure (cf. Szmrecsanyi & Kortmann 2012: 10). In Miestamo's (2009: 81) own words,

> [t]he absolute approach defines complexity in objective terms as the number of parts in a system, of connections between different parts, etc. […] The relative approach to complexity defines complexity in relation to language users: what is costly or difficult to language users (speakers, hearers, language learners) is seen as complex. Complexity is thus identified with cost and difficulty of processing and learning.

These terms are synonymous to what I have termed *qualitative naturalness* (= absolute complexity) and *processing naturalness* (= cognitive/physiological/social naturalness = relative complexity) in Section 1.1. Absolute complexity is additionally very close to the traditional, structuralist understanding of *markedness*, while the latter is very close to *usage-based approaches* of linguistics (see below). This way, all of these theories are closely related functional approaches to language. However, as already emphasized above, while the respective terms of these theories indeed appear like synonyms, meaning their conceptual difference is minimal, the connotations that they carry are not to be underestimated. As with *optimal* vs. *natural*, *complex* and *natural* are terms that are rooted in different theories and scientific communities. While ideas overlap significantly, these differing terms indicate the position of the scholars using them and as such, are interesting artifacts of the sociology of science. However, it is paramount to understand that differences that boil down to merely terminological matters should not stand in the way of a fruitful exchange of ideas between said theories.

1.5.4 Usage-based linguistics

The last approach that I want to mention in this chapter is the usage-based approach to linguistics, for it boasts noticeably more central commonalities with Naturalness Theory than it does differences.[84] In fact, these differences between the two approaches do not concern real points of discord, but merely differing priorities, i.e. some areas are more developed in one theory and less or not at all in the other. As has been repeatedly underlined in the course of this chapter, for Naturalness Theory, the study of performance is of utmost importance. This is also the cor-

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[84] This sentence might give the impression that there was *one* usage-based approach to linguistics. Ibbotson (2013: 10) cautiously warns against this view, stating that "there are almost as many usage-based theories as there are theorists".

nerstone of usage-based linguistics, whose proponents "have argued that the structure and organization of a speaker's linguistic knowledge is the product of language use or performance" (Diessel 2017). Language is treated as a tool of communication and "a complex adaptive system" (Ibbotson 2013: 12). Therefore, "the complexity [see above, D.M.] of language emerges [...] through the interaction of cognition and use" (Ibbotson 2013: 1), which perfectly corresponds with the central tenets of Naturalness Theory. For explanation, usage-based linguistics considers much of the same evidence as Naturalness Theory: among other things, it studies "how languages evolve, both in history and language acquisition" (Diessel 2017). It uses these domains not only as sources of evidence, but, inversely, also predicts "empirical findings in language acquisition, processing, and typology – domains that are not usually [...] brought together in this way" (Ibbotson 2013: 1). Naturalness Theory, too, brings such findings together. A crucial methodological point that the theories share is that linguistic units are not "determined [...] by theoretical fiat" but are instead "psycholinguistic units with which people operate [that] are identified through observation of their language use" (Tomasello 2000: 61, 62).

Positioning themselves within the realm of linguistic theories, proponents of usage-based linguistics unsurprisingly stress how it "stands in sharp contrast to the structuralist and generative approach" (Diessel 2017), and thereby highlight its closeness to Naturalness Theory. Both are functional theories in which, unlike in generativism, language is not seen as special or divorced from other cognitive processes (cf. also Section 1.2.4). Yet, these two theories do not explicitly reference each other, although usage-based linguistics is often characterized as having developed out of cognitive linguistics, which was at times discussed in relation to Naturalness Theory.

While in Naturalness Theory, principal focus is put on the semiotic metatheory and accordingly, linguistic structures are treated as signs whose semiotic features affect how we cognitively process them, usage-based linguistics – in accordance with Construction Grammar, with which it is also closely allied – treats linguistic phenomena as constructions, a construction being "a complex linguistic *sign* that combines a particular structural pattern with a particular meaning or function" (Diessel 2017, my emphasis).

One of the possible shortcomings of Naturalness Theory comes to light in this comparison: semiotics is said to directly affect cognitive processing, but what exactly is meant by *cognition*, which cognitive processes are affected by the semiotic structure of a sign, and how they are affected, remains largely implicit. As a more or less direct offshoot of cognitive linguistics, usage-based linguistics has a lot more to say about "a wide range of cognitive and social processes" (Diessel 2017) which are subsumed under the three general categories of social cognition, conceptualization, and memory and processing. In general, usage-based linguistics claims that linguistic structure is influenced

> by general cognitive processes that concern the categorization and conceptualization of experience [...], the representation and activation of knowledge in memory [...], the linearization of information in utterance planning [...], and the flow of consciousness in discourse processing [...]. (Diessel 2017)[85]

As already implied but not explicitly stated, usage-based linguistics, like Naturalness Theory, takes into account socio-communicative factors and culture, which complement cognition as explanations for linguistic structure (cf. Ibbotson 2013: 1).

Remarkable but not fundamentally conflicting differences between Naturalness Theory and usage-based linguistics concern, for example, the modeling of language acquisition, and, most crucially, the role that frequency plays as an *explanans* (cf. Ibbotson 2013: 2). The fact that

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85 The processes that Ibbotson (2013: 2) names overlap greatly with Diessel's list: "(i) categorization; identifying tokens as an instances [sic] of a particular type (ii) chunking; the formation of sequential units through repetition or practice (iii) rich memory; the storage of detailed information from experience (iv) analogy; mapping of an existing structural pattern onto a novel instance, and (v) cross-modal association; the cognitive capacity to link form and meaning".

such importance is ascribed to frequency – not only within usage-based linguistics but also, for example, as an alternative for markedness (cf. Haspelmath 2006) – has been criticized by Dressler, Libben & Korecky-Kröll (2014).

1.6 Summary

Naturalness Theory is a functional linguistic paradigm that interprets language as a tool for communication and cognition. Natural Phonology (NP), which originated in the late 1960s in the US, developed as its first branch. It positioned itself in sharp contrast to generativism and structuralism and took up pre-structuralist phonological ideas by, among others, Edward Sapir. The most central of these ideas holds that phonemes are mental sound intentions that speakers and hearers share. In a departure from rules and formal levels of phonological representation, and including a categorical distinction between 'pure' phonology and morphonology, NP's core tenet is that there exist phonological processes that are applied to eliminate phonetic – articulatory as well as perceptual – difficulties for speakers and hearers. As they are determined by human physiology, or human 'nature', they are termed *natural* phonological processes and give the approach its name.

From the mid-1970s, inspired by NP on the one hand and Roman Jakobson's (and in general, the Prague School's) work – most prominently the consideration of external evidence and the (re-)introduction of semiotics to linguistics – on the other, a second branch of Naturalness Theory began to be developed in Europe: Natural Morphology (NM). Semiotic/cognitive motivation was for NM what phonetic motivation was for NP. Accordingly, one of NM's central claims is that several features of the semiotic structure of a sign – understood as the relationship between the signans and the signatum – have bearing on the cognitive processing of said sign. Based on this assumption, several naturalness parameters were described; these are grounded in the features of semiotic structure and are said to be of cognitive reality.

Aside from the universal level – the only level explicitly treated in NP – that corresponds to a preference theory, NM added two additional subtheories: a typological subtheory and a system-dependent subtheory of naturalness. The former evaluates what is natural in language types, the latter what is natural in individual systems. "What is natural" boils down to the prioritization of the different naturalness parameters. In each system, all of them play a role, but they are weighted differently.

Aside from cognition, socio-communicative factors are crucial for NM as well: since language is a tool for communication, linguistic behavior is seen as a means for achieving social goals. This adds another layer of analysis, as the semiotic structure of signs cannot only be evaluated denotatively, but also connotatively: linguistic structures always reveal additional information that goes beyond mere propositions about the speakers/writers producing them. Under this perspective, phonology can become a semiotic affair, too: speaking sloppily, i.e. not pronouncing an utterance carefully, can not only be motivated solely phonetically, i.e. physiologically (for example by fatigue or intoxication), but there can also be a semiotic motivation: If a person speaks sloppily, this might also be due to the fact that the speech situation is very informal and he or she is talking to someone who is very familiar. In such a situation, the phonetic output is semiotically charged – it is a sign of the speech situation, the relationship between the interlocutors, etc.

External, or, in Naturalness Theory, 'substantial' evidence is central: data from language acquisition, language disorders, language change, etc. are taken into account in order to evaluate both natural phonological processes in NP and naturalness parameters in NM. The different motivations within the two subbranches – phonetics in NP, semiotics/cognition in NM – that are direct reflections of the differences between phonology and morphology, lead to varying understandings of 'natural'. While NP does not define naturalness as explicitly as NM, it is implied that naturalness is treated as an absolute attribute: everything that is phonetically realized by humans is phonologically natural since for it to have been materialized, it has had to go through several phonological processes that eliminated ‘unnatural’ obstacles. For NM, on the other hand, naturalness is a scalar, gradual concept: on each parameter, different degrees of naturalness can be evaluated ranging from more natural to less natural, for example: biuniqueness—uniqueness—ambiguity. A phenomenon x is thus always evaluated in relation to another phenomenon y with respect to parameter z. For the most part, naturalness is evaluated locally, of small-scale linguistic phenomena (such as words, phonological clusters, etc.) with respect to given parameters, and not globally, with respect to whole language systems. However, as findings in linguistic complexity research suggest, the naturalness/complexity of whole systems *can*, in theory, be evaluated, but this is a challenging endeavor.

Even though it is only explicated in NM, NP also works with a gradual rather than an absolute reading of naturalness: in the absolute reading, *everything* that occurs in language is seen as ‘natural’ since humans can process it. In a gradual reading, everything occurring in language can be compared and evaluated as more or less natural. Natural, in this gradual sense, means ‘easier to process for humans’, and this includes physiology (as in NP), cognition (as in NM), and social factors (as in both). It is this latter, gradual reading of naturalness that is vital for Naturalness Theory and, consequently, crucial for the proposal of a Natural Grapholinguistics in Chapter 3.

In the context of the ‘naturalness’ of writing, a second meaning of naturalness was discussed: naturalness as opposed to artificiality. While writing is indeed historically artificial since it was made by humans and did not develop as a natural (as opposed to cultural) phenomenon, the fact that humans *made* it and their continuous use *shaped* it led to the fact that synchronically, writing exhibits natural features that can be evaluated in the sense of Naturalness Theory: feature x of a writing system is more physiologically/cognitively/socially natural on the parameter z than feature y. This way, there can be naturalness in artificiality, too.

Following NP and NM, a number of other naturalist approaches were proposed and developed to varying degrees. They include Natural Syntax, Natural Textlinguistics, and Natural Pragmatics. This variety of approaches proves that the concept of naturalness – including natural processes and naturalness parameters – can be applied productively to other domains. This is a prerequisite for the present enterprise to be successful.

Figure 5 gives a schematic, non-exhaustive overview of the theory: it illustrates the semiotic metatheory as well as other influential theories and paradigms (preference theories, functionalism in general), the extralinguistic bases of naturalness (cognitive, physiological, psychological, sociopragmatic), the three subtheories (universal, typological, language-specific; the levels of norms and performance, since they are not developed yet, are missing here), the linguistic subdomains to which the theory can be applied (phonology, morphology, syntax, text, etc.), and finally, the external evidence that is crucial for the theory.

For terminological or conceptual reasons, some theories and paradigms are frequently associated with Naturalness Theory. One of them is Markedness Theory, which, because of the multitude of approaches using the term ‘markedness’, is better understood in the plural: *theories* that concern markedness. Accordingly, there exist numerous readings and meanings of markedness, but two of them are central in a comparison of markedness and naturalness. Originally, markedness was conceived of as a formal feature. A form that was bearing a mark was said to be marked, while the form without this mark was termed unmarked. This original sense that was developed by Trubetzkoy and Jakobson evolved in different directions. Gradually, it was reinterpreted as a functional term – a crucial step in that direction was Greenberg’s treatment of markedness. What is marked could thus be evaluated by the distribution of forms (the distribution of the marked being more restricted than that of the unmarked), the order of acquisition of forms (the marked being acquired later than the unmarked), etc. It is this functional reading of markedness that is the antonym of naturalness: what is marked is thus unnatural, what is unmarked is natural. However, after Naturalness Theory took up markedness as the polar opposite of naturalness, it diverged from Markedness Theory (or theories) and took on a life of its own. This is the reason I choose unnatural and not marked as the opposite of natural.

Another seeming antonym of naturalness is complexity. A problematic term itself, complexity has been defined in myriad different ways. However, a lot of the important findings of linguistic complexity research correspond to central tenets of Naturalness Theory. Thus – and this might appear a bit reductionist, but is overall quite accurate – *natural* can be read as *simple* (= the opposite of complex) which can be read as *unmarked* (= the opposite of marked). A final term that is associated with *natural* is *optimal*, which is deeply anchored in Optimality Theory, a generativist enterprise that breaks with some generativist cornerstones and integrates a certain dose of functionalism. Here, input candidates are evaluated with respect to universal constraints much like linguistic phenomena are evaluated with respect to naturalness parameters. This evaluation comes up with the *optimal* candidate. While the skeletons of the two theories are strikingly similar and *natural* and *optimal* can be seen as quasi-synonyms, Naturalness Theory and Optimality Theory do not overcome the fundamental differences between functionalism and formalism, as naturalness parameters are based on external evidence while optimality constraints are not. The former strive for psychological reality, the latter do not. In linguistic theorizing, *natural* and *optimal* are emblematic for a paradigmatic divide between functionalism and formalism.

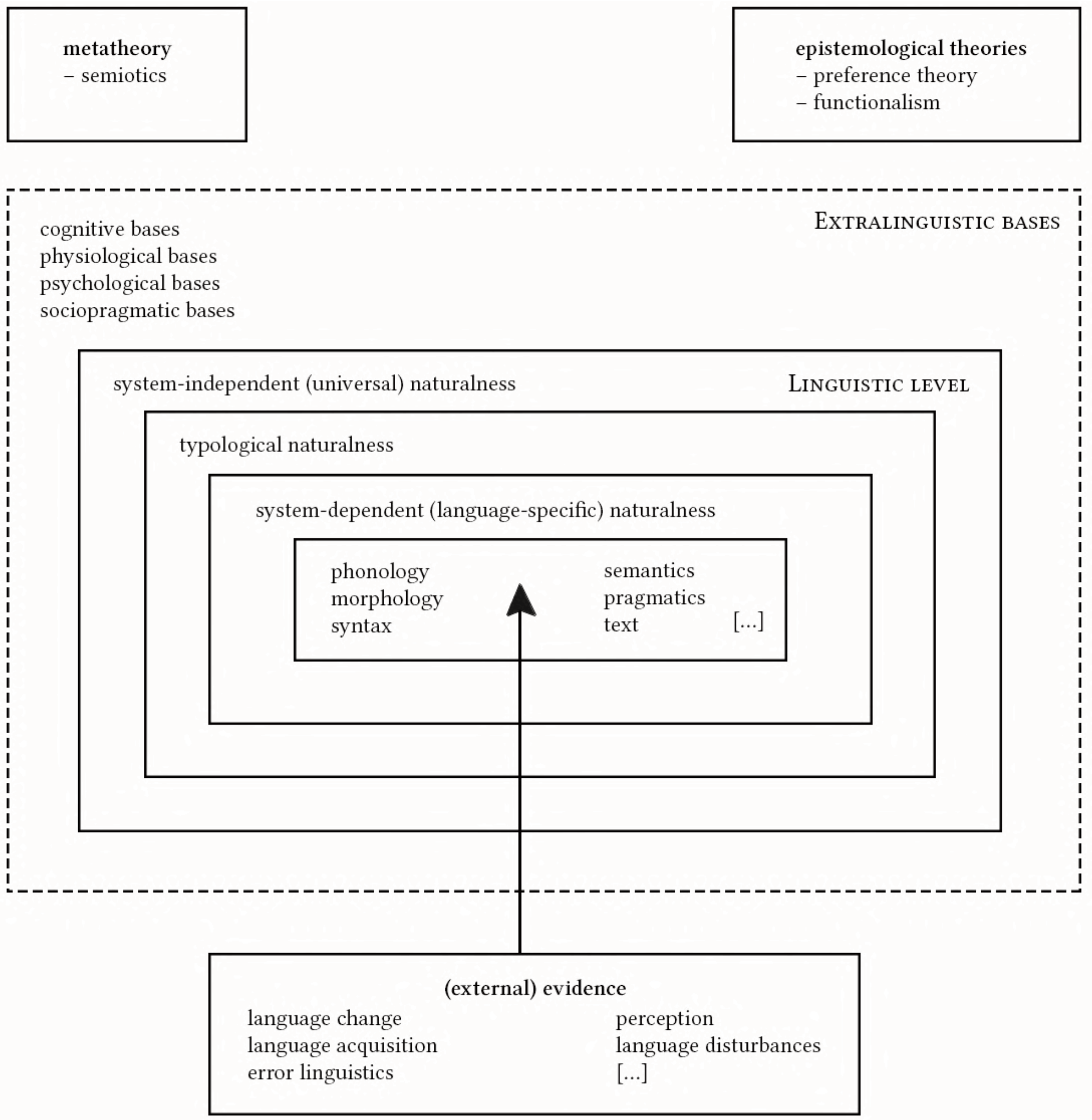

Figure 5: Structure of Naturalness Theory, translated and adapted from Sánchez Miret (2009: 182)

Naturalness Theory is not the only theory that is concerned with performance, i.e. the use of language and how it influences the structure of language. As an offshoot of cognitive linguistics, usage-based linguistic approaches show a significant theoretical and methodological overlap with Naturalness Theory. Slight but constitutive differences between the theories can be found in the structural interpretation of linguistic phenomena – as signs (Naturalness Theory) or constructions in the sense of Construction Grammar (usage-based linguistics) – as well as in the explicitness of the treatment of cognitive processes, which take center stage in usage-based linguistics and should, admittedly, be treated more explicitly in Naturalness Theory.

2 Grapholinguistics

> [...] writing is a system in its own right [...] (Vachek 1989: 7)
>
> There are many things that linguists should know about writing: more, in any event, than can be suggested in passing. (Coulmas 1989: 267)

Writing is the representation of language by visual or tactile means. But it is also much more. Coulmas (1989: 3) calls it "the single most important sign system ever invented on our planet". Although this is a provocative claim, I believe it is true. To accept it in this form, however, one has to clarify what is meant by "invented". Spoken and signed languages were not invented the same way writing was. They developed naturally, they are *natural*. Writing was invented. Although in the time since its invention, it developed organically similar to spoken and sign language, it was, at its inception, and still is, *artificial*. Thus, the difference between sign language and spoken language on the one hand and writing on the other is one of diachronic naturalness as outlined in Chapter 1. Keeping this in mind, writing is indeed the most important sign system ever *invented*. Nowadays, in literate cultures, writing is ubiquitous. While its status varies across cultures, it seemingly differs only in *how* writing is important, not in the fact *that* writing is important. With the advent of modern technologies and new forms of communication – many of which are written – writing is gaining even more currency. The fact that written communicateon unquestionably serves such a multitude of registers, contexts, and functions highlights that it has developed from a resource of the elite and the central cornerstone of culture to an everyday instrument for everyone who is literate. This is a result of the gradual democratization of writing. Academic communication and dissemination of knowledge, too, depends largely on writing, apart from talks at conferences and, to some degree, personal face-to-face communication – contexts in which speech prevails. Linguistics is no exception to this. Linguistic examples are always rendered in written form. Transcriptions, historical reconstructions – virtually everything in linguistics, except for corpora of spoken language, which, however, are often also transcribed, is written or written down at some point. Writing is the very tool that linguistics has always relied and depended on. Yet, ironically, as an object of linguistic study, writing had a pretty rough and delayed start, so to speak – or write.

This is not the place to lament that following Hermann Paul, Ferdinand de Saussure, Leonard Bloomfield and other like-minded thinkers (when it comes to matters of writing, that is), speech was recognized as the only valuable subject of linguistics and writing was neglected,[86] as this is already done abundantly in a great number of other publications focused on writing (cf. Dürscheid 2016: 13-19; Wehde 2000: 43-48; Coulmas 1981: 21-56). Writing, eventually, *was* accepted as a worthy object of study in linguistics. This, however, does not mean that it ceased to be ignored by the leading theoretical paradigms in linguistics. This ignorance, in turn, leads to a situation in which much of the research on writing does not manage to link to linguistic research from other areas and, more generally, theories of language. Neither generativism nor, to a large degree, structuralism or smaller enterprises such as Naturalness Theory have seriously thought about including writing. Accordingly, writing being acceptance by linguistic does not equal writing being integrated into linguistics. Consequently, while research on writing frequently includes references to findings from other domains, the same is not the case vice versa. It has oftentimes been pointed out that there exists an implicit *written language bias* (Linell 1982), also referred to as *scriptist bias* or *scripticism* (Harris 1980; Ágel 2003; Hennig 2006), that underlies linguistic theorizing and analyses. These terms refer to the bizarre situation in which

[86] These names are usually listed in the context of the neglect of writing as an object of linguistic study. However, as Glück (1987: Chapter 3) showed, dismissing these linguists as ignorant of writing is shortsighted, as a more elaborate treatment of their works reveals that their opinion of writing was not as one-dimensional as it is frequently depicted.

writing was dismissed as a secondary and sometimes unworthy object of linguistics, while at the same time, linguistic findings were based on or in writing. Ágel (2003: 8) gives the example of structural/syntactic ambiguity in generativism. A sentence such as *Flying planes can be dangerous*, he claims, is ambiguous only for a reader, not for a hearer, as the ambiguity can be resolved by prosodic features when the utterance is spoken. This way, paradigms such as generativism – with claims of a modality-indifferent competence – or structuralism – with its (initial) depreciation of writing –, underneath their explicit claims, actually relied on writing.

All of this strongly suggests that writing cannot be optionally investigated. It is not a subject that can be put aside for later or placed at the bottom of the list of linguistic priorities. An analysis of writing, its features and its categories is necessary for and actually inherent in many 'traditionally' linguistic analyses. The concepts 'word' and 'sentence', for example, are heavily influenced if not constituted by writing. In the same vein, some scholars even go as far as claiming that the phoneme is epiphenomenal in that its existence is constituted by the segmentality of alphabetic writing (cf. Faber 1992; Aronoff 1992). In other words, segmental thinking and segmental units of language may only be seizable for us *because of* writing. The strongest version of this view claims that writing does not merely make visible pre-existing units of language, but that these units are constituted by their visualization through writing. Even if there were only some truth to this claim – and I leave this question open –, it would mean that the study of writing is not just a peripheral task for linguistics, but instead one that is central. As a slowly establishing discipline, so-called grapholinguistics is the response to these considerations.

Grapholinguistics is the name of "the linguistic sub discipline dealing with the scientific study of all aspects of written language" (Neef 2015: 711). It is equivalent to German *Schriftlinguistik*, a term first proposed by Nerius & Augst (1988) and adopted by Dürscheid (2016) as the title of her seminal textbook.[87] I follow Neef, Sahel & Weingarten (2012ff.) as well as Neef (2015) in using this term instead of one of numerous available alternatives, such as *grammatology* (Gelb 1969; Daniels 1990, 2009a; in a different sense Derrida 1967), *graphonomy* (Hockett 1951; Daniels 2018), *writing systems research* (the title of a prominent journal in the field, see below), or *graphem(at)ics*. I choose *grapholinguistics* because it not only aligns terminologically with designations used for other linguistic subdisciplines, such as psycholinguistics and sociolinguistics, but also because it is a term that originated in and simultaneously reflects the longstanding German tradition of acknowledging and investigating writing and written language in their own right rather than as secondary and peripheral matters of linguistics, as I will show below. Additionally, unlike the other possible designations listed above, it is not already used as a label by other disciplines or endeavors.[88]

Leaving terminological preferences aside, what exactly is grapholinguistics – what does it cover, who are scholars working in this field? As Neef's quote cited above states, grapholinguistics is a linguistic field dealing with all things writing. In an influential linguistic dictionary written in German, *Schriftlinguistik* is defined as a "synoptic label for efforts of gaining con-

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87 A suggested French term is *scripturologie* (Klinkenberg & Polis 2018).

88 *Grammatology*, although it was first used in a grapholinguistic sense by Gelb (1952/1969), is most strongly associated with Derrida's (1967) philosophical theory of the same name, while *graphonomy* (or also *graphonomics*) is used as the designation of a field that deals with handwriting analysis. *Graphem(at)ics* is problematic since it, at least given the model of writing systems proposed here, only refers to a subdiscipline of grapholinguistics – the one devoted to the graphematic module (cf. Section 2.2). In mainstream linguistics, however, it is commonly interpreted as a *pars pro toto* designation equivalent to grapholinguistics (cf. e.g. the Wikipedia page for graphemics, https://en.wikipedia.org/wiki/Graphemics, March 5th, 2019). *Writing systems research* is the only name that is not already taken and that would suit the discipline. Although its focus on writing systems is obviously justified, the term insinuates a narrower scope than what is studied by grapholinguistics: for example, solely graphetic research endeavors, such as studies that test what connotations or emotions different fonts evoke, are definitely grapholinguistic but are not *per se* about the writing system. Such questions might not always be seen as *writing systems* research.

sistent descriptions and analyses of the written form of language and of developing them to a general theory of writing as a constitutive part of a general theory of language"[89] (Glück 2016d: 596, my translation). The theory of writing referred to in this definition is still lacking. As Dieter Nerius, likely the founder of the term, noted, the designation is intended to highlight the integration of the treatment of writing into linguistics (cf. Dürscheid 2016: 12). As such, however, *Schriftlinguistik*, while somewhat established, is still notoriously underrepresented both as a term and more generally, as a subdiscipline of linguistics. Yet, as Dürscheid (2016: 11) observes, the situation is improving: for example, a grapholinguistic dictionary (the above-mentioned Neef, Sahel & Weingarten 2012ff.) is in the works alongside a series of dictionaries for linguistic subdisciplines such as morphology and syntax which are undoubtedly established. The discipline is now more often named beside other linguistic disciplines. Workshops and conferences are devoted to it, and, finally, it is treated by an increasing number of classes in linguistics programs.[90] This all sounds like a promising leap into the right direction, but it is not a reason to be all too hopeful, as grapholinguistics is nowhere close to being a coherent field. And here, interestingly, as implied above, the English-speaking community lags far behind the German-speaking community. Since there is, in fact, no perception of a coherent field, drafting a historical reconstruction is challenging.[91] Nonetheless, I will attempt to sketch some relevant milestones in the slow but steady development of grapholinguistics and a scientific community devoted to writing.

It is not surprising that *Schriftlinguistik* is a more widespread term than the English equivalent *grapholinguistics*,[92] as this terminological observation only reflects the field's varying prominence across different linguistic realms. In the German-language area, especially in Germany, aspects of writing and written language have been treated as valuable subjects of linguistics since roughly the second half of the 20th century. One might argue that some of the most important – and first – monographs on writing, including Gelb's *A Study of Writing* (first published in 1952, cited here as Gelb 1969) and Diringer's *The Alphabet* (first published 1948), among others, were written in English, and indeed, to this day, the most relevant monographic works on writing and writing systems are in English (Coulmas 1989, 2003; Sproat 2000; Rogers

[89] „Zusammenfassende Bez. für Bemühungen, konsistente Beschreibungen und Analysen der geschriebenen Sprachform von Spr. zu gewinnen und sie zu einer allgemeinen Schrifttheorie als konstitutivem Bestandteil einer allgemeinen Sprachtheorie zu entwickeln."

[90] A quick search for grapholinguistic classes in the German-speaking area showed that introductory courses to *Schriftlinguistik* (and sometimes, additional courses focused on specific phenomena of writing) are or were at one point in the recent past offered in, among others, the universities of the following cities/areas: for Austria – Graz, Innsbruck, Vienna; for Germany – Wuppertal, Köln, Oldenburg, Leipzig, Jena, Saarland, Kassel, Osnabrück, Duisburg-Essen, Aachen; and for Switzerland – Zurich. Additionally, I found an introductory class at the German department of the University of Athens, Greece.

[91] While a multitude of histories of writing exist, there are virtually no histories of the study of writing, with only a few exceptions: firstly, a handbook chapter by Schlieben-Lange (1996), which, however, covers the 20th century only sparsely and was published before the 21st century that proves so central for grapholinguistics, and secondly, an extensive overview in Spitzmüller (2013: Chapter 3), which interested readers can consult. Both are written in German. A number of reviews by William C. Watt (e.g. Watt 1989, 1998, 2002) in which writing-related works are discussed, provide historical grapholinguistic context and critical readings thereof.

[92] The English term *grapholinguistics*, in fact, has virtually never been used except by Neef and me. One use I found (albeit hyphenated as *grapho-linguistics*) is by Penny Platt: "Graphic images are part of a visual vocabulary which has intense personal meaning to the child. There is a symbolic relationship among drawing, writing, reading, speaking, and listening. The meshing of all these processes rightfully belongs to a new science which I have named grapho-linguistics" (Platt 1977: 263). This, obviously, does not correspond with the reading of *grapholinguistics* advocated here. Another less-received use is by Anthony W. Sariti in a paper (Sariti 1967) covering the Chinese writing system, entitled *Chinese grapholinguistics* and based on his master's thesis. He notes that the "Grapholinguistic System (GS) is concerned with what we usually call the 'written language', that is, it is manifested not by acoustic but by graphic events (writing)" (Sariti 1967: 3, emphasis in original). From this quote, it seems that he uses *grapholinguistic system* in a way that is synonymous to *writing system* as used in this thesis.

2005; Sampson 2015; Daniels 2018), as is the case for one of the central edited volumes (Daniels & Bright 1996), an encyclopedia (Coulmas 1996a), and a comprehensive bibliography (Ehlich, Coulmas & Graefen 1996). Considering monographs alone, there is nowhere near this breadth of grapholinguistic overview works in German. Why then, do I argue that the German-language community has been more instrumental in the development of grapholinguistics? My argument hinges predominantly on the concepts of 'community' and institutionalization. Secondarily, most English grapholinguistic research is distinct from German research in its epistemological interest.

In the German-language realm, it appears, acceptance of writing as a linguistic subject and, probably of greater importance, a growing interest in actually studying it, were more widespread: Dürscheid (2016: 12) traces the development of grapholinguistics as she mentions two influential German research groups devoted to writing. They originated in the then-separated parts of Germany: *Forschungsgruppe Orthographie* (founded in 1974 in the GDR), and *Studiengruppe Geschriebene Sprache* (founded in 1981 in the FRG). Some of the most influential "grapholinguists" were members of these groups, including, for the former group, Dieter Nerius, and Gerhard Augst, and for the latter, Florian Coulmas,[93] Konrad Ehlich, Hartmut Günther, Peter Eisenberg, Otto Ludwig, and others. These scholars are all linguists or Germanists, and their interest in writing and written language is not marginal in their respective lists of research interests – it is central. As Günther (1990a) argued, in the years leading up to 1990, more than 15 habilitation dissertations submitted in Germany were devoted to aspects of writing and written language.[94] Based on this, he concludes that a paradigm shift had occurred, as linguists no longer had to justify their interest in writing. This development initially culminated in the two volumes of the handbook *Schrift und Schriftlichkeit* (*Writing and its Use*), edited by Günther and Ludwig (with help from the remaining members of the group *Geschriebene Sprache*) and published by De Gruyter in 1994 and 1996, respectively. The handbook boasts over 140 German and English chapters dealing with a vast spectrum of aspects of writing and unites a great number of scholars interested in the field, including even the former "rivals" from the *Forschungsgruppe Orthographie* such as Dieter Nerius, and non-German scholars. Strikingly, however, the term *Schriftlinguistik* does not occur even once throughout the entire handbook, implying that even though for the first time, a handbook was devoted to this topic – notably, an extremely elaborate two-volume handbook – there was still no perception of a coherent field studying it – yet.

Evidently, in the German-language area, there is/was a stronger network of people invested in writing. The second major difference between the Anglo-American and German treatments of writing is that in the latter, the topic is approached in a more theoretical, explanatory matter, whereas in publications by English-speaking scholars, the focus is much more on description. This coincides with a focus on synchrony in the German grapholinguistic tradition and diachrony in the Anglo-American tradition. Works such as Rogers (2005), Sampson (2015), and Daniels (2018), and also the contributions in Daniels & Bright (1996), offer excellent descriptions of a great variety of the world's writing systems, but when they broach theoretically linguistic aspects of writing as a general phenomenon, they do not reach the sophistication brought forth by the German grapholinguistic tradition. Most strikingly, they do not offer methods or categories for further productive linguistic analyses of writing systems (a theoretical chapter in Rogers 2005, a book that is advertised as a textbook, is an exception). Inversely,

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93 Coulmas is one of the few members of this group who also publishes frequently in English although he is a member of the German community. This, to some degree, opened up topics treated in the German community to an English-speaking audience as well. Additionally, he also published in French, cf. his chapter in Catach (1988). He is interested in writing systems beyond German, including Japanese and Chinese. His 2003 monograph, however, in its epistemological interest, its makeup, and its aims resembles the other English-speaking descriptive works of writing systems and includes little of the theoretical footing previously established in German grapholinguistics (partially even by himself).

94 This tradition continued, as between the early 2000's and today, German linguists Martin Neef, Nanna Fuhrhop, Ursula Bredel, and Kristian Berg, among others, also devoted their habilitation dissertations to aspects of writing and written language.

German grapholinguistics has focused heavily on these theoretical aspects, asking how writing systems *can be* described instead of 'merely' describing them. However, in the process, it has sacrificed a greater, more universalist horizon, as its theoretical findings and proposals are mostly based on the analysis of alphabetic writing systems, predominantly German (cf. Fuhrhop 2018). Ironically, a mixture of the two approaches seems most fruitful: careful descriptions of vastly diverse systems can only inform theoretical work, including models, units, and, in general, abstractions. Sadly, there seems not only to have been a massive lack of reception of German literature on behalf of English-speaking scholars,[95] but readily available English literature is often also not considered in German works. Not to mention the lack of reception of grapholinguistic findings from other regions, for example from France, where in 1962, Nina Catach founded the research group *Histoire et structure des orthographes et systèmes d'écritures*, a group that very productively investigated writing and written language. In sum, one could conclude there is a lot of valuable grapholinguistic research scattered around various academic cultures and published in different languages and across various academic fields, waiting to be integrated into a coherent overall picture – which is a little bit like putting together a large puzzle.

Even though *Schriftlinguistik* was not a label the above-mentioned handbook *Schrift und Schriftlichkeit* (Günther & Ludwig 1994, 1996) put on itself, it already foreshadowed what Dürscheid would later term *Schriftlinguistik* in her seminal textbook *Einführung in die Schriftlinguistik* (first published in 2002, cited here in the fifth edition of 2016). In fact, the handbook's preface offers what I would argue is the best characterization of grapholinguistics found in the literature:

> Due to the diversity and heterogeneity of the subject areas [covered by the handbook, D.M.], a number of different scientific disciplines need to be involved in studying them: philosophy and anthropology, linguistics and literary studies, sociology, psychology, education, history – to mention merely a few. […] The form which research takes in a given discipline reflects the theories and methods relevant to the respective field; the findings are thus tied to these individual theories and methods. Each discipline studies a given aspect of *Writing and Its Use*, and a relatively complete picture can only emerge when all of them are combined in some way. In this sense, *Writing and Its Use* is an interdisciplinary subject, and research needs to take this into account. […] the study of *Writing and Its Use* has been restricted to isolated research interests of the individual scientific disciplines. *Writing and Its Use* has thus never become a research subject in its own right, which is why as yet there is neither a unified theory nor has there been an interdisciplinary exchange of theories, problems, and research methods.
>
> (Günther & Ludwig 1994: XXVIII f., emphasis in original)

If, in this quote, *Writing and Its Use* is changed to *grapholinguistics*, this assessment perfectly sums up the state of grapholinguistics not only as it was more than two decades ago but also its current state.[96] The many disciplines that Günther & Ludwig list are partially echoed in the subjects Dürscheid includes in her textbook, which features chapters on the relation between spoken and written language, writing system typology, the history of writing, graphematics, orthography, typography, and reading and writing acquisition. While this list does not approach the breadth of topics covered by the handbook described above, and the textbook's fo-

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[95] There are exceptions to this: some works of the German-speaking community were dispersed in English, for example in the edited volumes *Writing in Focus* (Coulmas & Ehlich 1983) and *New Trends in Graphemics and Orthography* (Augst 1986), volumes to which not only German grapholinguists contributed, but also scholars working on various aspects of writing from other academic cultures and regions, among them Jack Goody, David R. Olson, Margaret Martlew, William Haas, Max Coltheart, and Nina Catach.

[96] This is echoed in Judson's (2017) review of a more recent volume dealing with historical graphematics and its 'concepts and methods' (Cotticelli-Kurras & Rizza 2017). In her review, she implicitly criticizes the lack of comparative and interdisciplinary grapholinguistic theory: "What the introduction to this volume lacks […] is a broader theoretical or methodological discussion of the book's potential interdisciplinary impact: how developing methodological approaches to or studying particular aspects of one writing system may help to illuminate others".

cus is clearly linguistic, it does reflect the interdisciplinary nature of the field. Why, then, is grapho*linguistics* still a fitting designation instead of the more neutral graphonomy, grammatology, or writing systems research? As I will argue below, writing in a narrow sense refers only to those graphic (visual and/or tactile) “marks” that represent language – and not ideas or extra-linguistic referents. As such, writing is always intimately tied to language, and language is the subject of linguistics. The term *grapholinguistics* highlights this linguistic basis while the analogy to psycholinguistics, sociolinguistics, etc. also hints at the inherent interdisciplinarity. It implies that the discipline does not exclude the findings, methods, and theories of other disciplines.

I want to propose a distinction for grapholinguistics that is common in other linguistic subdisciplines: *theoretical* vs. *applied grapholinguistics*. Whether this division is necessary or useful is debatable, and in fact, this thesis is located somewhere between these two poles, if a little bit more on the theoretical end on the spectrum. Theoretical grapholinguistics deals with the theory of writing, which this chapter and a large part of the following chapter on the naturalness of writing are devoted to. Its immediate subbranches are *graphetics*, *graphematics*, and *orthography research*.[97] Applied grapholinguistics, on the other hand, deals with but is not reduced to questions of how this theoretical knowledge can be put to use for “writing-related real-life problems”.[98] This includes educational, psychological, and medical questions, for example literacy instruction or the diagnosis and treatment of disorders that affect reading and writing. This thesis is of relevance for applied grapholinguistics insofar as its findings will hopefully be of use for those real-life writing problems as well (see the discussion in Section 3.5).

To end this brief historical sketch of grapholinguistics, I want to focus more closely on the present and, even more importantly, the future by asking: what is the current state of grapholinguistics? It might be pessimistic to phrase it like this, but the discipline’s ‘heyday’, if it ever really experienced one, appears to lie in the past: to my knowledge, there is no contemporary equivalent to the research groups named above, and not all of the members of these groups are still active (or as active as they were before). Although some steps are taken in the ‘right’ direction, the question is whether they suffice. As yet, there exists no chair for grapholinguistics (again: whatever it would be called) anywhere in the world, nor is there a department for it or a linguistics program devoted to it.[99] This lack of institutionalization results in the fact that many of the findings that would be most important for the discipline are still scattered across the many fields involved, and that there is still no theory (as was also assessed in the introduction to this thesis), or, in other words: there *still* is no discipline as such.

Even today, I believe it is hard to find people who identify primarily as scholars of writing, ‘grapholinguists’, so to speak. Scholars such as the late Earl M. Herrick or Peter T. Daniels[100] might be exceptions to that. Expertise in the field of writing systems is commonly perceived as icing on the cake, not a foundation in itself. I experience this on a regular basis when I am asked *what other* linguistic interests I have besides grapholinguistics, since research in that area alone does not suffice to be a full-fledged and serious linguist. Contrary to this, I claim:

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97 In German, *Orthographie* not only designates the phenomenon ‘orthography’, but also the field studying it, which is a common form of polysemy for linguistic terms (cf. *phonology*, *morphology*, etc.). In English using *orthography* for a field of study seems odd, so I felt compelled to add *research*.

98 This is a slight modification of Wikipedia’s definition for *Applied linguistics* (cf. https://en.wikipedia.org/wiki/Applied_linguistics, June 6th, 2018).

99 As of June 2016, there was a plan for a Master’s programme at the University of Haifa in Israel, entitled *Literacy Development and Writing Systems*. It is/was planned as an “inter-disciplinary approach to the study of literacy learning across languages and writing systems” that bridges psychology and linguistics (David Share, p.c.).

100 In fact, in an *About the author* section, Daniels is described as “one of the few linguists in the world specializing in the study of writing systems” (Daniels 2006b: 45), which underscores that grapholinguists are a rare species.

grapholinguistics is not a hobby, it is not a side line. It is a serious field of study, and a subdiscipline of linguistics. This is highlighted by the fact that to study it seriously, one needs a broad knowledge of many other subfields of linguistics that are relevant in writing. The present thesis is a product of this thinking.

The picture is not quite as grim as the preceding paragraphs make it seem: first of all, with two high-ranked journals solely devoted to writing, *Written Language and Literacy*[101] (founded in 1998) and *Writing Systems Research*[102] (established in 2009), and additionally *Scripta*[103] (also since 2009), not to mention writing-related journals from the other disciplines involved in grapholinguistics,[104] there are now official and well-known ways of disseminating the disciplinarily heterogeneous findings that can be subsumed under the heading of grapholinguistics. With at least four series of conferences devoted to writing – the international workshops of the *Association of Written Language and Literacy*, a series of workshops entitled *The Idea of Writing*, proceedings of which have been published in an eponymous series by Brill, another series with the name *Laut Schrift Sprache* (English title: *Script and Sound*), and the international conferences of the *Hunmin jeongeum Society* which also publishes the journal *Scripta* – and an increasing number of workshops and sessions at general conferences devoted to the topic,[105] there is an opportunity for scientific exchange. Germany still remains the heart of the international grapholinguistic community, with scholars in Cologne (e.g. Beatrice Primus, Martin Evertz, Frank Kirchhoff), Oldenburg (Nanna Fuhrhop, Kristian Berg, Franziska Buchmann), Osnabrück (Karsten Schmidt), Hildesheim (Ursula Bredel), Braunschweig (Martin Neef, Miriam Balestra), Hamburg (Jannis Androutsopoulos, Florian Busch), Bochum (Sven Osterkamp, Gordian Schreiber) working on questions of writing and written language, only to name a few (and most certainly unknowingly leaving out many). Important and central publications to the field keep appearing, such as Daniels (2018), a culmination of his scholarship from almost three decades,[106] or Domahs & Primus (2016), a handbook that places written language alongside spoken language and sign language and weights all of them equally. Finally, there are numerous grapholinguistic dissertations in the works that will also hopefully help flesh out the field.

In this chapter, I will first present open questions of an age-old issue, the relationship between speech and writing (Section 2.1), since the views regarding this question are constitutive and axiomatic for the model of writing systems that will be presented thereafter, so much so that differing opinions with respect to this question lead to vastly different treatments of writ-

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[101] https://benjamins.com/catalog/wll (June 8th, 2018).

[102] https://www.tandfonline.com/toc/pwsr20/current (June 8th, 2018).

[103] http://www.scripta.kr/ (June 8th, 2018).

[104] Examples are *Reading and Writing* and *Scientific Studies of Reading*. These journals are not exclusively or even primarily linguistic, but since they focus on the production and perception processes of writing and reading, what is published in them counts as grapholinguistic research. This is reflected by their own assessment as interdisciplinary, which is common for grapholinguistic research. Another example is *Visible Language*, an interdisciplinary design journal that focuses on visual communication research and has published a breadth of grapholinguistic literature, among which are some of Herrick's contributions.

[105] In this vein, the international, interdisciplinary conference *Graphemics in the 21st century – From graphemes to knowledge* held in June 2018 in Brest, France is worth mentioning, but also workshops such as *Written and spoken language as modalities of one language system* (Conference of the German Linguistic Society, February 2016) or *Theories and methods of grapholinguistics* (Austrian Linguistics Conference, November 2016).

[106] Note that Daniels's work remains descriptive and historical. It greatly informs grapholinguistics, but it is not *per se* grapholinguistic itself. Daniels (1991) himself foreshadowed this as he rejected a 'structural graphemics', and with it the concept of investigating writing with the same methods used in the study of language. In this vein, calling his work 'grapholinguistic' would contradict his own assessment. However, his work is ideally combined with an unlikely complement: the very structural 'graphem(at)ics' that he rejected and that is encapsulated, for example, in Fuhrhop & Peters (2013). This structural graphematics has, ironically, suffered from a narrow typological (read: alphabetocentric) horizon that Daniels's comprehensive and minute descriptions of a wide range of writing systems could help widen.

ing. Against this background follows the heart of the chapter: in Section 2.2, a modular model of writing systems is presented that is based on the groundbreaking work by Neef (2005, 2015). Language systems, graphetics, graphematics, and orthography will be described as modules constituting writing systems. After a general introduction to the model, each of the modules specific to writing will be treated in detail: Section 2.2.1 delves into the graphetic subsystem of writing systems, while Section 2.2.2 tackles graphematics and Section 2.2.3 asks relevant questions about orthographies. This thesis is comparative in nature, and as such, aims to refine existing typologies of writing: in Section 2.3, taxonomies of writing systems and ideas for a possible typology of scripts will be dealt with. Section 2.4 revisits the issue of the relationship between writing and speech, draws conclusions, and attempts to answer the initially asked open questions based on the findings of the chapter. Finally, in Section 2.5, a summary of the chapter is given that leads over to the main part of this thesis.

2.1 Prologue: The relation between speech and writing

> [...] contrary to received opinion ([...] in all cases misguided), the written language is not just parasitic on the spoken, it has a life of its own. This does not in any way imply, as Jacques Derrida and his more credulous epigones would have us believe, that the written language is somehow primary and the spoken, secondary; what it does imply is that the written language, in addition to or apart from slavishly representing the spoken language – obviously its primary function – has to a surprising extent its own and idiosyncratic rules, which have developed and are to some extent obeyed independently. They are, therefore, of course, all the more worthy of linguistic inquiry.
>
> (Watt 1994b: 96)

What is the relation between speech and writing? is the unavoidable question that must precede any structural and functional study of writing systems. Addressing this question is imperative since *any* analysis of writing systems is automatically informed by an answer to it, even if that answer is often rather preliminary and vague. Simultaneously, it is a controversial and often emotionally charged question in that certain answers to it can be – and have been – instrumentalized as justifications to discount writing as an object unworthy of linguistic study. All too often, however, this seemingly unanswerable question and attempted answers remain implicit in (grapho)linguistic works (cf. Dürscheid 2016: 41) and must be reconstructed from the methods and results of the respective analyses. When the question *is* treated explicitly, unsurprisingly, as so often in grapholinguistics, confusion wreaks havoc. The reason for this lies in the differing interpretation of a number of terms that are inherent to this question, among them *dependency*, *autonomy*, *representation*, *reference*, and finally, *language*, *speech*, and even *writing* itself. Differing readings of these terms necessarily lead to different conceptualizations of the relationship between writing and speech. In this prologue to the structural analysis of writing systems, I want to clarify some of the confusion and present this question in its complexity, so that unanswered aspects can be treated in the remainder of this chapter.

The first and arguably most pressing problem with respect to this question is the fatal lack of differentiation between language and speech. In it lies the crux of many misconceptions, and the equation of language and speech is at least a partial reason for the fervent rejection of the claim that "writing *represents* language". Speech is, in fact, the unmarked reading of *language* (cf. Waugh 1982: 308f.; Pettersson 1996). However, this does not mean that every time one speaks of *language*, what is meant is *speech*. While it is undeniable that some conceptions have done so intentionally, speech and language must be treated as different phenomena and kept apart both conceptually and terminologically. To sum up the difference between them, language is an abstract system, whereas speech is one of the modalities through which this abstract system is materialized. Critical contentions such as "there is no language that cannot be materialized by speech" or "there is no language if not through materialization" – whose accuracy shall remain implicit at this point – must be discarded initially, as in a first step, I argue, it is necessary to interpret language as an entirely abstract system consisting of various levels: the morphological, syntactic, semantic, pragmatic, etc. levels. The omission of phonology in this list is not accidental, as the question of where it exactly fits into this picture is a crucial part of the answer to how speech and writing are related. So, is phonology just another level of language? And does phonology equal speech? These are two of the questions that are seldom raised in the context of the relationship between speech and writing – but they must be, and I will address them now.

Works treating the relation between speech and writing often describe two opposing views, sometimes also termed 'hypotheses', a terminological choice that highlights that answers to the question are not absolute, but preliminary. This emphasizes that there cannot be a definite answer in this respect, and adhering to one of the possible answers always represents a (methodological) choice (cf. Eisenberg 2006). In this vein, Berg (2016b: 1) argues that "the derivative nature of writing should be a hypothesis, not an axiom", although this does not reveal what writing could be derivative of. In German grapholinguistics, the two opposing views mentioned are termed *dependency view* and *autonomy view* (cf. Glück 1987: Chapter 3; Dürscheid 2016: 35-42). The autonomy hypothesis is seldom interpreted as assuming complete autonomy, as no scholar of writing "seriously claims complete autonomy" as "written and spoken language exhibit regular correspondences on many levels of linguistic description, segmental, syllabic, and morphological" (Berg 2012: 26). Thus, a compromise was found in the intermediate, less radical *interdependency view* that claims spoken and written language exist as two relatively autonomous systems displaying the aforementioned correspondences (cf. Dürscheid 2016: 35; Glück 2016a: 301f.).[107] What these views stand for – more precisely, what *dependency* and *autonomy* refer to – is also not entirely agreed on. For Glück (1987), dependency refers to the fact that writing is dependent on language, while for Dürscheid (2016), it roughly means writing is dependent on speech. Inversely, autonomy means for Glück that writing is autonomous of language, for Dürscheid merely that it is autonomous of speech. This leads back to Berg's quote given above, in which it is not clear what "the derivative nature of writing" is referring to – language or speech? I argue that writing, in the definition I adhere to, is necessarily derivative of and even dependent on language, and this is not a hypothesis, but, in fact, an axiom that is part of the very definition of writing. Before I elaborate on that, consider Figure 6 which illustrates the three different core positions.

Let me start with the view that writing is autonomous of language. In this view, writing is seen as an entirely different system, as its own language, so to speak. Accordingly, there is a language system that is spoken – which does not warrant equating it with speech, since it is still an abstract system that is only *materialized* by speech – and then, independently of it, there is a distinct language system that is written. In other words, speech and writing are not two materializations of the same system, but materializations of two distinct language systems. Whether writing, as its own language, has the same sublevels as the other language (the "spoken one"), namely morphology, syntax, etc., remains an open question. In this view, a written word and its spoken equivalent are not two different materializations of the same word – rather, they are translations from one language to another. In fact, this resembles the actual relation between spoken language and sign language, which is also often a matter of confusion.[108]

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[107] In the German original, they are labeled *Dependenzhypothese*, *Autonomiehypothese*, and *Interdependenzhypothese*. In the literature, these views have been given various names, including *representational conception* (*Repräsentanzkonzeption*) for the dependency hypothesis and *distinctiveness conception* (*Distinktivitätskonzeption*) for the autonomy hypothesis (cf. Günther 1988: 72). It must be critically reevaluated, however, if these pairs of terms truly are to be treated as synonyms, as dependency and representation are related, but not identical concepts.

[108] Cf. Domahs & Primus (2016), a handbook dedicated to spoken, signed, and written language. Its organization implies that correlations or correspondences between speech and writing are to be treated analogously to correlations or correspondences between speech and sign language (or writing and sign language, for that matter). This obscures the fact that these relations differ fundamentally (cf. Meletis 2017).

It is frequently assumed that sign language is a modality of the (primarily) spoken language. This is not accurate. Sign language is its own language. And in this case, it is clear that sign language has its own "phonology" (cf. Sandler 2012), its own morphology, syntax, etc. A German word and its counterpart in Austrian sign language, for example, are certainly not two material shells for the same underlying linguistic representation; they are different words in two different languages. While in the case of sign language vs. speech, this reading of the autonomous view is accurate, with respect to writing vs. speech, it is untenable. Neither diachronically nor synchronically is writing its own language system.

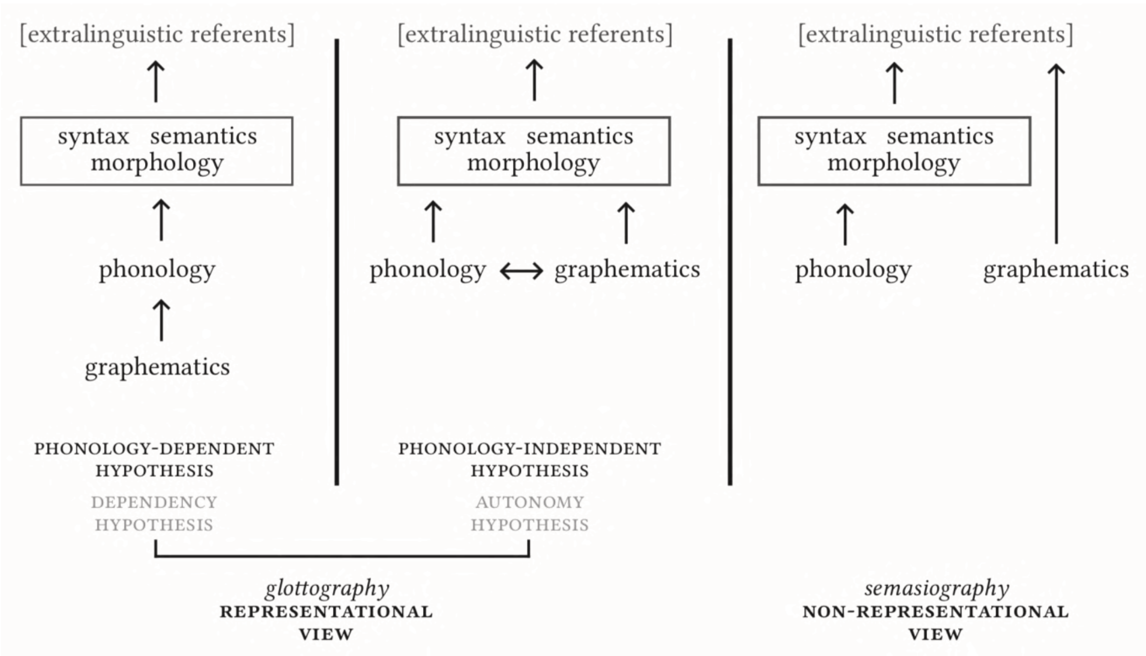

Figure 6: Different views of the relationship between writing and speech

As evident from Figure 6, I follow Dürscheid in restricting the label *autonomy hypothesis* to refer to writing's autonomy from speech, not language. The assumption that writing is independent of language is instead referred to as *non-representational hypothesis* (cf. Pettersson 1996). This non-representational hypothesis is closely linked to concepts such as *semasiography* and *ideography*. Both of these terms refer to the idea that signs of writing can and do directly refer to referents of the real world without a detour through language. Such a semasiographic definition of writing is given by Boone (1994: 15): "We [...] can define writing broadly as the communication of relatively specific ideas in a conventional manner by means of permanent, visible marks".[109] This is what has sometimes been referred to as the *broad definition of writing* (cf. Boone 2004: 313). Like most other scholars of writing, I disagree with this view and adhere to the *narrow definition of writing* instead which defines as writing only so-called *glottography*, literally "language writing", i.e. writing that represents language. Semasiography, for which street signs or cave paintings serve as examples, cannot be *read*, if reading is defined as the faithful decoding of a linguistic message that was encoded by a writer. Semasiography – even if it represents "relatively specific ideas" – can only be *interpreted*. These ideas might be specific, but the way they can be verbalized is not. Asking a number of people what a specific street sign *means* will – provided they know its function – yield the same or very similar interpretations, and these are by all means conventionalized, but when asking them to *read* a sign, this will likely not result in the same linguistic representations since no fixed linguistic referents are associated with it. Fixed linguistic referents, however, are a prerequisite for the narrow defini-

[109] In Boone (2004), she critically reevaluates this definition of writing in light of the narrow definition.

tion of writing. As Daniels (2018: 157, emphasis in original) puts it, "the crucial point of this definition is that writing represents *language*".

With that, we return to the vagueness of the relevant terminology referred to above, a large part of which is a lacking or overly imprecise definition of writing. If, however, writing is defined exclusively as the visual (and tactile) representation of language, then not only is this relation axiomatic for every analysis that adheres to this definition of writing, but it also means that the non-representational view must be rejected. There is both functional and structural evidence that supports this.

For functional evidence, it is helpful to look at sign language, and specifically the process of literacy acquisition in deaf people. While there exist attempts at creating writing systems for sign languages, among them SignWriting or HamNoSys (cf. Hopkins 2008), these are not commonly used in everyday life, so what I outline here is the acquisition of the writing system of the 'dominant' language, i.e. the language that is primarily spoken. In what follows, I only want to capture the essence of the relevant arguments; for a fuller picture, cf. Goldin-Meadow & Mayberry (2001) and Petitto et al. (2016). Many, though certainly not all, deaf people in literate communities learn to read and write. This process, however, is self-evidently not as straightforward as for hearing people, which is already an indication that writing might not be completely independent of speech, either. Since the writing system that deaf people acquire is not a writing system that represents *their* language system (that would be a writing system such as the above-mentioned SignWriting and HamNoSys), learning to read and write means not just learning a new modality of a language system they already master, it rather amounts to second language acquisition. Even more so, it is the acquisition of the *secondary* modality of a second language. Where it gets challenging is the fact that the primary modality – the spoken modality – is not, or only to a limited degree, accessible to deaf people. Reading and spelling, thus, are more challenging tasks to master for them than for hearing people. If writing were its own system entirely and not dependent on either speech or the underlying abstract language system, the relation between sign language and writing would be equal to that of speech and writing. It is not.

One last observation from literacy acquisition in deaf people strongly suggests that writing is dependent on language: deaf people who have acquired sign language are better readers than deaf people who have neither acquired spoken language nor a sign language (because they were born to hearing parents, for example). Writing, it seems, can only be learned if competence exists in a language system that written units can be linked with, whether this is spoken language or sign language. This is astonishing insofar as the written units that are acquired are not directly related to the units of the sign language they are linked with. They do not represent them. Still, preexisting units of language make it possible to link the written units to *something* linguistic, and that is the crucial piece of evidence that strongly indicates writing is dependent on language. This does not mean that writing is necessarily dependent on the language of which it is a modality, but *any* language, and it points to the fact that writing is not a language system in and of itself.

The fact that speech precedes writing both phylogenetically and ontogenetically is often cited as evidence that writing is secondary to speech. What is not considered in this argument is that writing does not only follow speech, it can also not be acquired *without* speech (or sign language, see below). Writing can neither be the first language – since it is no language itself – nor the first modality of a language that is acquired. If a child acquires German or ASL as a first language, the first modality acquired will always be spoken or signed language, not writing. By contrast, writing can be the first (and sometimes only) modality of a second language that is acquired – consider Latin or Ancient Greek, for example, languages that are exclusively acquired through writing (cf. Dürscheid 2016: 37). The acquisition of the German writing system by an L1 signer of Austrian sign language is another example.

From a structural point of view, too, the complete autonomy of writing from language is questionable. First of all, if writing was to communicate "relatively specific ideas" instead of linguistic units, as Boone claims, then there would be a need for a sufficient number of written units to communicate all of these "specific ideas", whose own quantity is – for lack of an operationalized definition of "specific ideas" – difficult or even impossible to assess. This problem is reflected by actual writing system typology: there exist no writing systems for words, sentences, or texts, since these units are members of open classes, and such an open writing system seems unmanageable. Also, with respect to the structural makeup of writing, it is absurd to explain away the conspicuous isomorphy between units of writing and units of language – and this means not only phonological units in phonographic writing systems. As I will argue below, it cannot be treated as accidental when there are roughly as many graphemes in alphabets as there are phonemes in the given languages or that there exists a grapheme in Chinese for every morpheme. This isomorphy is something the non-representational hypothesis cannot account for.

Even after it is clear that writing represents language and, thus, is dependent on language, the question of how writing relates to *speech* still remains. To address it, I want to further specify the terminology and refer to the remaining two views – which can be subsumed under the heading of *representational hypotheses* – as the *phonology-dependent* and the *phonology-independent hypotheses* (cf. Figure 6). The fact that writing is representational, i.e. dependent on language, already reveals a part of the answer to the question of whether writing is dependent on speech. If writing represents units of linguistic levels, such as the morphological, why should it not represent units at the phonological level as well? It clearly does. This, in fact, is not denied by anyone, as I argue below, although the details of how the relation between phonology and writing is treated differ considerably. Three main misconceptions plague the perception of the phonology-dependent hypothesis: a) that phonology equals speech, b) that all features of writing are constituted by the dependency of speech (or rather, phonology), and c) that writing is dependent on speech renders writing an object unworthy of linguistic study. Before I continue with a characterization of the two hypotheses, these three misconceptions regarding the phonology-dependent hypothesis will be addressed one by one.

a) Phonology equals speech. I want to argue that speech and phonology are not the same, just like writing and graphematics are not the same. While phonology is the deepest abstract sublevel of language that writing – though certainly not all writing – is dependent on, speech is the umbrella term for the acoustic materialization of language. As such, it definitely includes phonology as an important part, but phonetics and prosody are equally parts of it. Phonetics and prosody, in fact, are also the reason that speech, as a material substance, exhibits a number of features that writing lacks. The transmission of data is acoustic, not visual, so the two modalities, from a material point of view, function completely differently and are necessarily characterized by idiosyncratic features that are not shared by the other. Phonetics, and, to a large degree, prosody, are not represented in writing, as only phonology is represented. Thus, in order to be treated reasonably, the question *Is writing dependent on speech?* has to be reformulated as *Is writing dependent on phonology?* While it somewhat contradicts the naturalist definition of the phoneme given in Chapter 1, for a clarification of the relation between writing and phonology, it helps to conceptualize the phoneme as the smallest lexically distinctive contrast in language. This definition of the phoneme, of course, only opens the floodgates for the next question, a question of causation: if graphemes constitute lexically distinctive contrasts in writing, is it *because* they refer to phonemes or do they have this function on their own? This question has engaged almost all German grapholinguists in the past. I argue that it cannot be answered without expanding the view to non-alphabetic writing systems. If this is indeed done, pressing questions such as *If graphemes refer to morphemes in Chinese, why should they not refer to phonemes in an alphabet?* become inevitable. As a core issue in the question of the relation between writing and speech, the grapheme will be dealt with elaborately in Section 2.2.2.1.

b) If writing is dependent on speech (or even just phonology), all features of writing must be explainable through this dependence. This is simply not true. First of all, phonology is an abstract system and, as described above, only a part of speech. Again, many of the respective features of writing and speech stem from the fact that they are different materializations. Dürscheid (2016: 24-35) lists some of the most relevant differences between them, and the majority can be traced back to the fact that speech depends on and extends in time, while writing depends on and extends in space, which also determines that speech is continuous while writing is segmented. Accordingly, it is only logical that writing and speech each have features and resources that cannot be found in the other. This, however, must be stated as an objective fact and must not be used as an argument to devalue one of these materializations. It might not be possible to record the volume of a voice or the emotion conveyed in it in writing, but it is equally impossible to utter something in speech that is written in italics or with underlining, although, as these parallels imply, functional similarities might be found in the distinct resources of speech and writing.[110] In sum, writing is not deprived of anything when compared to speech, nor is speech lacking anything when compared to writing.

In any case, a comparison of features that are constituted by the respective substance is only reasonable to some degree, so the relation referred to in the title of this section can be narrowed down even further. Writing is not dependent on speech, they are two different substances, and only the abstract level that contributes to speech is of interest: phonology. Furthermore, it is not everything in writing that is dependent on phonology, but graphematics. The answer to the question *Is writing dependent on speech?* is, thus, 'no'. What is often meant by this question is accurate, however: graphematics is dependent on phonology. And even this is not the whole truth, as not all graphematic modules of all writing systems depend on phonology, even if the majority does. It is paramount to note that an acknowledgment of this dependence does not insinuate that some features of writing were not independent and did not have to be analyzed independently. As the autonomists argue correctly, graphematics' dependence on phonology only goes so far.

c) The phonology-dependent hypothesis entails that writing should be dismissed as its own worthy object of linguistic study. Since there is some truth to it, this misconception proves persistent. In her characterization of the phonology-independent hypothesis (in her terminology the autonomy hypothesis), Dürscheid (2016: 38, my translation) notes "autonomy theoreticians argue the case for a treatment of writing as its own object of research that is to be distinguished theoretically and methodologically from speech".[111] This passage implies that grapholinguists who assume graphematics is dependent on phonology – and who stand in opposition to the "autonomy theoreticians" – believe that writing is *not* its own object of research. This view is based mainly on a number of highly prominent 20th-century linguists who are often cited as regarding speech as the only valuable and 'true' object of linguistics, simultaneously discarding writing as a mere visualization of speech without a 'life of its own'. Among them are Saussure, Bloomfield, and Paul. In general, the structuralist and Neogrammarian schools are blanketly dismissed as being hostile to writing. Glück (1987: Chapter 3) offers a fine-grained treatment of this situation and concludes that these linguists' view that "writing" is dependent on "speech" is not inseparably linked to the opinion that writing should not be studied on its own (cf. also Spitzmüller 2013: 82f.). Accordingly, I argue that it is possible and even reasonable to acknowledge a certain relation of dependence between graphematics and phonology while still treating writing as a linguistic subject, even proclaiming and supporting the establishment of grapholinguistics, an entire linguistic subdiscipline devoted to it. If the relevance that 'autonomists' vs. 'dependentialists' attach to writing as a linguistic subject is discarded as a constitutive difference between the two views, the true crucial difference between them must be acknowledged: methodology. To do that, a closer characterization of the hypotheses is necessary.

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[110] An example for this is the fact that writing in ALL CAPS is often interpreted as a written equivalent to shouting in speech, so there appear to be ways in which some functions of speech or writing are being intermodally compared.

[111] „Die Autonomietheoretiker plädieren dafür, die Schrift als eigenen Forschungsgegenstand anzusehen, der theoretisch und methodisch von der gesprochenen Sprache zu unterscheiden ist."

The autonomy hypothesis (cf. Figure 6: middle), which I specified further as the phonology-independent hypothesis, does not proclaim that graphematics is completely independent of phonology, but what it does postulate is that it should be studied autonomously (for an overview of the autonomy view, cf. Enderle 2005). This is captured perfectly by Eisenberg (1988: 29, my translation):

> The structural analysis of writing divorced from speech can make sense even when writing is functionally and genetically subordinate to speech in every respect. The postulate of a graphematics that is independent of phonology exists for the simple reason that because of it, a projection of the structure of speech to writing is avoided. This is necessary since otherwise structural features of writing could remain unseen.[112]

All of what Eisenberg describes here is true. In this sense, the autonomy hypothesis is not incompatible with the dependency hypothesis – indeed, it is its logical precursor. Whereas for proponents of the dependency hypothesis, the correspondences between written units and linguistic units constitute the smallest units of a writing system, for autonomy hypothesis, the written units alone are the smallest units. For autonomists, possible correspondences – for example the so-called *grapheme-phoneme-correspondences* – are only the next, and sometimes not even a necessary, step in a graphematic analysis. Thus, the crucial difference between the two hypotheses lies in their respective conception of the *grapheme*, a concept that is discussed in detail in Section 2.2.2.1. However, with respect to methodology, I do want to mention here that in the autonomous view, the graphemes of a writing system are discovered distributionally. This way, graphematics is not treated as dependent of phonology, but as parallel to it. This method of handling graphematics *analogously* to phonology raises a number of other problems. Ultimately, it means that in this view, too, graphematics is somewhat dependent on phonology: not structurally, but methodologically. The irony of this is that proponents of the autonomous view explicitly aim to uncover features that are characteristic of writing and have no reflection in phonology or speech – however, they strive to do so by applying to writing a methodology that was established for phonology. Thus, the smallest units of writing – the graphemes – are defined as the smallest lexical contrasts in writing, in parallel to how phonemes are defined as the smallest contrasts in speech. The description of a graphematic syllable (cf. Section 2.2.2.3) in writing systems using Roman script is another achievement of the autonomists, as it is defined through mere visual – that is, writing-internal, or, in their terminology, "inner-graphematic" – terms. From this follows that the phonology-independent hypothesis is plagued by two grave problems: 1) given its methodological dependence on the structural definition of the phoneme and its simultaneous rejection of phonography, it is inherently alphabetocentric and Eurocentric, and 2) it heavily mixes the material (= graphetic) and linguistic (= graphematic) aspects of writing.

As this section serves only as a prologue, the two problems mentioned above shall be touched on only briefly here: 1) the first problem results from the fact that the discovery procedure for graphemes is analogous to the discovery procedure for phonemes. Consequently, it only works for writing systems in which graphemes also correspond with phonemes, i.e. alphabets and other segmental phonographic writing systems such as abjads and abugidas (cf. Section 2.3.2). For other types of writing systems – even phonographic ones, such as syllabic writing systems, let alone morphographic systems – this discovery procedure does not work. What is termed "autonomous methodology" really is trapped in phonology's corset, after all. This results in a situation in which these conceptions regard only the smallest units of alphabets as so-called graphemes, whereas the smallest units of other writing systems are labeled, for example, "syllabograms" and "logograms" (cf. Glück 1987: 57). This corresponds with the au-

[112] „Die vom Gesprochenen losgelöste strukturelle Untersuchung des Geschriebenen kann auch dann sinnvoll sein, wenn das Geschriebene dem Gesprochenen funktional und genetisch in jeder Beziehung nachgeordnet ist. Das Postulat einer von der Phonologie unabhängigen Graphematik besteht einfach deshalb, weil damit eine Projizierung der Struktur des Gesprochenen auf das Geschriebene vermieden wird. Das ist notwendig, weil sonst strukturelle Eigenschaften des Geschriebenen ungesehen bleiben könnten.“

tonomous "axiom" that these writing systems – syllabographic and "logographic" writing systems – are "self-evidently" to be analyzed differently than alphabets. Ironically, terms such as "syllabogram" and "logogram" insinuate a strong connection between the written units and the linguistic units that they relate to, something that is explicitly avoided for the "grapheme", which would accordingly and consistently have to be called "phonogram". The question of how syllabograms and logograms can be 'discovered' is not treated in autonomous works, as they only ever structurally treat alphabets. The autonomy hypothesis might be best suited for isolated descriptions of individual writing systems (more precisely, only phonologically segmental writing systems), but it reaches its limits when it comes to cross-grapholinguistic comparison or the description and explanation of universal tendencies across typologically diverse writing systems. Newer conceptions (such as Berg 2018) rely on distribution; however, the core of the grapheme definition remains the fact that it is claimed to be lexically distinctive. This all leaves open the question of how a distributional grapheme could be assumed in non-alphabetic writing systems. If the criterion of lexical distinctiveness cannot be upheld across writing systems, this raises the question of how different "graphemes" of diverse writing systems can a) be discovered and on what grounds they can b) be compared.

2) One of the strongest arguments of the autonomy hypothesis, as evidenced in Eisenberg's quote, is that an analysis of writing in which it is treated as divorced from speech is the only reasonable (and sometimes in fact only possible) method of uncovering the features that are specific to writing and that have no equivalences in speech. As Coulmas (1996a: 177) puts it, "written language has properties not found in spoken language, and vice versa, and [...] therefore a structural description of both must precede an analysis of how sound system and writing system relate to each other". As I argued above, this is true only partially. The same way I postulated that graphematics is dependent on phonology, I want to suggest that graphetics, the subbranch studying the materiality of writing (see below), is *not* dependent on phonetics. As such, graphetics is the core discipline in which questions of modality-specific features of writing are bundled. Surprisingly, with the exception of few programmatic suggestions (cf. Günther 1990b, 1993), graphetics is heavily underdeveloped and underrepresented in works adhering to the autonomous view. Indeed, some aspects that would correctly have to be categorized as graphetic are sometimes classified as graphematic instead. This is nowhere as obvious as in the discussion of the so-called "graphematic syllable" (cf. Section 2.2.2.3), the definition of which hinges on visual, i.e. graphetic criteria. An immediate result of this is that script-specific features are included in the definition of the "graphematic syllable", in this case features of Roman script, making the definition anything but universally applicable. This, in and of itself, is not a problem, as the description of system-specific features is a valuable endeavor (cf. also Haspelmath 2010). It becomes a problem only if one takes issue with the fact that a concept such as the "graphematic syllable" is not just writing system-specific but in fact script-specific. This, together with the phoneme-inspired definition of the grapheme outlined above, underlines that the autonomous hypothesis makes a comparison of writing systems that also includes non-alphabetic writing systems almost impossible. If the "inner-graphematic" features of writing – the features that are not dependent on other linguistic levels, including phonology – were actually treated as what they mostly are, as *graphetic* features, there would, in fact, be no need for a strong rejection of the claim that graphematics is dependent on phonology. Graphematics could deal with the features of writing that can be assumed across writing systems, features that stem from the fact that writing, as established above, represents language, i.e. phonology, morphology, etc. The separation of graphetics and graphematics is a core feature of the model of writing systems that I present below (cf. Section 2.2).

The phonology-dependent hypothesis (cf. Figure 6: left) has its share of problems, too, but I argue that what it claims is conceptually closer to reality than the phonology-independent hypothesis. The strongest characterization – and strongest weakness – of the hypothesis is, again, found in its definition of the grapheme. What is defined as a grapheme by dependentialists is the "depiction" of a phoneme. While this, in essence, is true, the problem lies in the direction of analysis, and the weighting of phonology vs. graphematics. In the phonology-dependent view, what is usually done is compiling a list of phonemes in a language's phoneme inventory and positing the corresponding "graphemes" that depict those phonemes. This distorts the picture and insinuates that graphemes are nothing but "visual phonemes". They are not. For graphematics, it is not relevant how every phoneme in a language is written. Instead, the inverse direction of analysis should be in focus: what phonemes do graphemes correspond with? While this adjustment already results in a more economic endeavor, it would still lead to the assumption of graphemes such as German <ng>, since in <singen> 'to sing', it corresponds with, or "depicts", the phoneme /ŋ/. What is missing, thus, is a writing-specific criterion of minimality that can overwrite the criterion "depicts a phoneme", as <n> and <g> are already independent graphemes in German. Such a criterion of minimality is proposed in Section 2.2.2.1. Obviously, a problem that the phonology-dependent hypothesis shares with the phonology-independent hypothesis is the focus on the phoneme. In one case, it is a unit of correspondence, in the other case a model for a discovery procedure. However, despite its problems, the phonology-dependent view is more easily extendable to other linguistic levels and is thus better suited for an application to non-alphabetic writing systems. If a core criterion for the grapheme is that it represents a linguistic unit – this includes syllables and morphemes – this already highlights what diverse writing systems have in common *graphematically*, regardless of how distinct they are graphetically (see above).

Dürscheid (2016: 36) lists two arguments in favor of the view that writing is logically dependent on speech: there exists no language which has writing but does not have speech[113] and writing is secondary to speech both phylogenetically and ontogenetically. These are generally agreed upon both by dependentialists and autonomists (cf. Birk 2013). Thus, the difference between these views is located, as we have seen, on the methodological and structural levels. Crucially, the autonomists argue that writing's logical dependence of speech does *not* entail structural dependence. However, a more universal look at this question that includes non-alphabetic writing systems raises serious challenges for this view of structural independence. The key lies in the two core problems introduced above: the autonomous, analogous definition of the grapheme (Section 2.2.2.1) and the definition of a graphematic syllable (Section 2.2.2.3). At the end of this chapter, an epilogue will bring together the findings of the subsections and draw conclusions that shed further light on the question of how writing and speech relate to each other.

2.2 Structure of writing systems

In grapholinguistics, a model of the general structure and functioning of writing systems is an absolute necessity. Only if we have understood how writing systems are structured, we can adequately formulate and study questions of grapholinguistics. This opinion, however, has not always prevailed, and in fact, most of the research on writing systems does not explicate the respective model of writing systems that it is based on. This, one could argue, is due to the fact that much of this research has no model or theory at all as a basis. The starting point for the model that I propose is Neef's (2012, 2015) *Modular Theory of Writing Systems*. It aims at describing the subsystems or – as the name suggests – *modules* that constitute writing systems. A modified version of it is illustrated in Figure 7: it features (I) a language system, (II) graphetics, and (III) graphematics as obligatory modules, and (IV) orthography as an optional module of writing systems. In the following, these modules and their interrelations will be characterized briefly, before respective subchapters deal with the writing system-specific modules of graphetics, graphematics, and orthography in detail.

113 This should be extended to "there is no language with writing but without speech or a signed modality", as not only speech but also signing can serve as first modalities of a language and as a basis for writing.

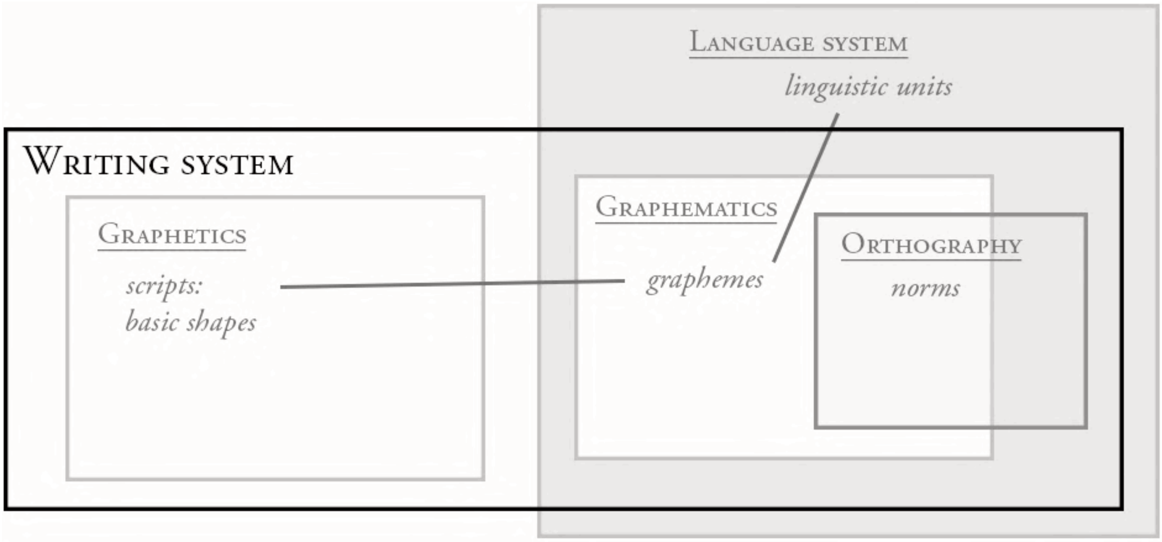

Figure 7: Multimodular model of writing systems, from Meletis (2018: 61)

A **(I) language system** is the basis of a writing system and its core module. Accordingly, following this model, there is no writing without an underlying language system. Note that this is not the only possible way to see things, but rather an axiom of the narrow definition of writing which interprets solely the graphic representation of language as writing (cf. also Section 2.1). Writing, in this sense, is *always* glottography ('language-writing'), and *never* semasiography ('meaning-writing', cit. Gelb 1969: 12; Schmitt 1980: 7-11). Semasiography, the direct representation of thoughts, a context in which nebulous and largely abandoned terms such as 'ideography' are often encountered, is, in the contemporary *opinio communis*, generally not acknowledged to be writing.[114] As an example of this module, consider the German language system as the core of the German writing system. It is structured into linguistic units at various levels: phonemes, syllables, etc. as units of sound, morphemes, lexemes etc. as units of meaning, and phrases, sentences etc. as larger chunks of language that are constituted by smaller units of the lower levels. The observation that one of these linguistic levels is predominantly represented in a given writing system – in the case of German, it is the phoneme level – is used in classical writing system typology to determine the type of a writing system (see Section 2.3). Units of the German writing system primarily represent phonemes, consonants as well as vowels. This view, however, which is sometimes reductionistically dismissed as 'phonocentrism', does not deny that other linguistic levels such as morphology are also of relevance in the writing system.

On a more general level of a typology of writing systems, the most crucial distinction is made between writing that represents *sound* (phonography) vs. linguistic *meaning* (morphography, logography). Units of sound such as phonemes, syllables, etc. do not bear meaning, their only function is to differentiate meaning. Morphemes as well as lexemes, on the other hand, *do* bear meaning, by which they simultaneously also differentiate meaning. At the same time, these meaningful units can be pronounced, as they have a phonological representation, i.e. are

[114] The concept of *pictography* should not be abandoned in the same vein as ideography. It is correct that nowadays, in most writing systems, there is generally no iconic relationship between the visual basic shape of a grapheme and the meaning of its signatum, as basic shapes – even those which at some point were pictographic – have become increasingly abstract (cf. Section 3.3.1.2). This, however, does not mean that the possibility of pictography should be excluded. Pictography, in this sense, is to be understood as a feature of writing systems and not a type of writing systems. This means that a morphographic grapheme – a grapheme that has a morpheme as its signatum – can be pictographic when its basic shape visually resembles the object referred to by the signatum of the morpheme, e.g. a tree. What should be discarded, though, is the idea that pictographic graphemes refer directly to the concepts they depict. This view succumbs to the same fallacy as the assumption of ideography, i.e. that writing can refer to extralinguistic referents (or 'ideas') directly. If this is assumed to be the case, we are dealing with the broader definition of writing that includes semasiography.

made up of phonemes. Language, in this sense, is doubly articulated or dually patterned (cf. Martinet 1949). This fact directly informs grapholinguistic research, as will become evident in the discussion of the Chinese writing system, in which the most central graphematic relation is that between written units and morphemes. These morphemes, however, also always directly correspond with a pronounceable syllable. Not seldom has there been a discussion of just how "phonetic" the Chinese writing system is, and consequently, the question has been raised whether all writing is to be regarded as phonographic (cf. DeFrancis 1989).

This basic distinction in phonographic vs. morphographic systems is based on the fact that only linguistic levels that are made up of a (relatively) closed set of units can be used as base levels for writing systems. Phonemes, syllables, and morphemes are potential – and not always equally suited – candidates for the basic linguistic unit to be represented by graphemes, but not words (here: polymorphemic units), sentences, or texts (cf. Meletis in press a; Sampson 2015: 32). A system in which graphemes stand for sentences or whole texts (cf. the notion of discourse writing in Hill 1967) would have to consist of an infinitely large inventory of graphemes and would thus strain the memory of its readers and writers to an unimaginable degree. Logically, this seems impossible.

A script serves as the visual substance of a writing system and is at the core of the second module. However, it is not only the discrete basic shapes of scripts such as |R| or |a| as well as digits, special characters, and punctuation marks that constitute the visuo-graphic substance of writing systems, but also an abundance of other resources (such as bold print, underlining, layout, etc.), which is why this module shall be more broadly termed **(II) graphetics**. In Figure 7, I intentionally positioned it outside of the language system, although as the material substance of a specific writing system, it closely interacts with language. This outside position is justified by the fact that, from the perspective of a given language, the choice of script (and other visual resources) is theoretically arbitrary.[115] Given languages could be – and, over the course of history, have been – written using various scripts. Consider Azeri, which has been written in Arabic, then Roman, then Cyrillic, and again Roman scripts (cf. Hatcher 2008; Section 3.2.3). German, for example, could also very well be written with other basic shapes than Roman script (and it was, in fact, also written in other scripts such as Fraktur). Coulmas (1996b: 1380, emphasis in original) offers a definition of *script* that fits the model proposed here: "*Script* refers to the actual shapes by which a writing system is visually instantiated. […] Every writing needs for its materialization a script, but there is no necessary link between a particular script and a particular writing system".

As Coulmas mentions, there is prototypically no link between a script and its language or writing system. However, there are exceptions in which such a link exists. To distinguish between these two possibilities, it is vital to compare the processes of *script creation* and *script adoption* (cf. Rogers 2005: 4f.). Script creation refers to the process that in some rare instances, in the context of devising a new writing system, a new script is created from scratch specifically for the given language. In this case, the graphic units – the basic shapes (cf. Section 2.2.1.2) – are closely linked to the linguistic units since they are 'custom-tailored'. Reflections of this can be found not only in the number of basic shapes that might roughly correspond to the number of linguistic units that need to be represented in writing but also in features such as pictography, in which there is a special relationship between the graphic substance and the linguistic content, and which is a feature characteristic for the first writing systems ever invented (cf. Section 3.3.1.2). Both of these aspects are of different weight in script adoption, where an existing script is adopted and, sometimes, adapted for the writing system of a language that it was *not* originally devised for.

In terms of frequency, script adoption and adaptation can be declared the default. It occurs commonly in the creation of new writing systems: using an already existing script, most

[115] In fact, visual resources that are superimposed upon scripts such as bold print, italics, etc. seem to be more universal than the scripts themselves.

prominently the Roman script, is done for economical, technological, as well as political and sociocultural reasons, reasons which will be discussed in the context of the *sociocultural fit* of scripts (cf. Section 3.2.3). In such cases, the starting point is an already existing script, an inventory with a certain number of available basic shapes. People working on the new writing system can make use of only these preexisting basic shapes or, if necessary, they can invent new shapes, omit superfluous ones, and/or refunctionalize or modify shapes (cf. Daniels 2006a).

However, labeling this process merely as *script* adoption is reductionist, as it is most frequently not solely the basic shapes that are borrowed from one writing system to the other. Often, it is also the graphematic relations with linguistic units that are transferred. What is adopted, then, is not just basic shapes, but underspecified graphematic relations, underspecified *graphemes*. It is therefore terminologically more adequate to speak of *grapheme adoption*. For example, when the basic shape |a| is adopted by a new writing system, of course not in isolation, but together with other basic shapes from the Roman script if not the entire Roman script, it will in (almost) all cases be employed to represent a vowel, typically an open unrounded vowel. While the linguistic units – in this case phonemes – that are signified by the original grapheme and the borrowed grapheme might not be identical, they are often similar to a certain degree.

Yet, there are other – much rarer – cases of 'pure' script adoption. An example is the invention of the Cherokee writing system. In this system, it is, in fact, exclusively a number of (uppercase) basic shapes that have been transferred from the Roman script. In Cherokee, however, they enter quite different graphematic relations than in most other writing systems using Roman script, not least because the Cherokee writing system is syllabic and not alphabetic. For example, the basic shapes |A|,[116] |W|, and |L| represent the syllables /go/, /la/, and /tle/, respectively. This and only this is to be considered as *pure script adoption*, since units of script are transferred from one writing system to another stripped from the graphematic values they were originally associated with.

As this example proves, scripts – divorced from the graphematic relations that they take part in – are fairly arbitrary. This justifies their position outside of language. However, they must be placed within writing systems. At any given point in time, a writing system must be materialized by a script, or, in the case of *biscriptality* or *multiscriptality*, by more than one script (cf. Section 3.2.3). The script at the center of a writing system can be changed, however, as writing systems can switch from one script to another, which occurred when Turkish switched from Arabic to Roman script in 1928 (cf. Wood 1929).[117] Scripts, thus, are interchangeable. Still, as indispensable parts of writing systems, they take on an important role in the material makeup of graphemes and as such are perceived as intricately linked with the linguistic units they signify.

Another reason to position scripts outside of language is the fact that scripts can be used for purposes of non-linguistic graphic notation. Writing, as I defined it, is the graphic representation of language. However, other, non-linguistic referents can be written (or better: 'noted down') as well, for example in mathematics or dance and music notation, where scripts are utilized for other purposes than writing. In this case, we speak of notation systems rather than

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[116] Graphetic units are enclosed in vertical strokes | | and graphematic units in angle brackets < > (cf. Berg & Evertz 2018: 190).

[117] Note that the Turkish writing system employing Roman script is a different writing system than the Turkish writing system using Arabic script. The reason for this is that in this case, it is not just the visual substance (the basic shapes) of the graphemes that is switched, but also the type of linguistic unit signified by them. In other words, the two systems differ typologically: while the first system is an alphabet, the latter is an abjad (a phenomenon referred to as *intersystemic biscriptality*, cf. Section 3.2.3). Hypothetically, two different scripts can materialize one and the same writing system. In that case, however, only the visual basic shapes are switched out while the linguistic units they represent remain stable. Most frequently, however, as in the case of Turkish, when a language has been or is being written with two or more scripts, the different graphematic relations associated with those scripts mark them as distinct writing systems, even if the underlying language system is the same.

writing systems, with the latter being a subtype of the former. These non-linguistic functions, however, are only secondary functions of scripts that are primarily used for writing.

A special comment shall be made about the first times writing was conceived – *ancient grammatogenies*, as Daniels (2013: 56) calls them. Presently, following the hypothesis of the polygenesis of writing, it is assumed that this occurred at least[118] three times, uncontestably in Mesopotamia, China, and Mesoamerica. These ancient creations of writing systems as instances of the invention of writing itself represent special cases, as here, right from the beginning, basic shapes were created in close, almost inseparable connection with the linguistic units they signified. To reuse a term from above, they were 'custom-tailored'. These are true instances of script creation. What distinguishes these ancient creations of scripts and writing systems from modern creations is that the inventors involved in the former did not have any examples to fall back on. They did not invent only writing systems, they invented writing itself. In *modern grammatogenies*, i.e. modern creations of writing systems – whether they are *sophisticated* or *unsophisticated*[119] – there is always at the very least the preexisting knowledge of the concept of writing.

Next up is the heart of writing systems: **(III) graphem(at)ics**[120] fulfills the task of relating units of scripts with linguistic units. Accordingly, the graphematic module is constituted by relations, which I interpret as semiotic relations.[121] As I will argue, the smallest of these graphematic relations is simultaneously the smallest abstract unit of writing systems: the *grapheme*.[122] Since it is an infamous unit let alone a controversial term, it will be discussed in detail in Section 2.2.2.1.

In the context of graphematics, talk is often of relations or correspondence rules between units of script and linguistic units. The smallest of those relations is what I interpret as the grapheme, a dyadic sign in the Saussurean sense, with two inseparable constitutents: to use Jakobson's terms already introduced in Chapter 1, the *signans* which is a unit of script, the most elementary one being the basic shape, and the *signatum*, a linguistic unit. What makes the conceptualization of graphemes challenging is the fact that there is frequently more than one possibility on both sides: on the one hand, there can be various signantia in the sense of abstract basic shapes – |a| and |ɑ| differing significantly but being assigned the same graphematic value – or concrete graphs – millions of concrete visual manifestations of basic shapes, such as |a|, |a|, and |a|, representing the same basic shape in different typefaces. Furthermore, altogether distinct basic shapes such as |v| and |f| can both be signantia for the same signatum. In the German writing system, they can both represent the phoneme /f/. On the other hand, there can also be more than one signatum: a single basic shape such as the aforementioned |v| can be part of

[118] Rogers (2005: 4) notes that "[s]ome scholars have claimed that the Egyptians and the people of the Indus Valley also invented writing", but that "these claims are controversial".

[119] These are Daniels's terms. In an *unsophisticated grammatogeny*, the inventor of a writing system "was not literate in any language but only knew by observation that writing existed" (cf. Daniels 2007: 56f.). By contrast, in a *sophisticated grammatogeny*, the inventor is literate (cf. also Daniels 1992: 85; Daniels 2013: 55).

[120] In most works, *graphemics* and *graphematics* are treated as synonyms (cf. Glück 2016e: 253), i.e. as equivalent in meaning. However, sometimes, a semantic distinction is made between them: in Fuhrhop & Peters (2013: 203), for example, the adjective *graphemic* is used with respect to the grapheme as a unit, whereas *graphematic* refers to graphematics as a module of writing systems and a level of grammar/language as a whole.

[121] The treatment of writing systems as semiotic systems in which written units *represent* units of language is not uncontroversial and unproblematic (cf. Harris 1994). However, in line with a number of recent approaches (cf. Klinkenberg & Polis 2018; Rizza 2018), I opt for a semiotic analysis. In no way do I claim to give an answer to the question of *how* written units signify units of language (cf. Harris 1994: 45), as I merely posit that written units *do* signify units of language. However, the semiotic parameters presented in Section 3.3.1 help to characterize the nature of the relations between them.

[122] Note that there are some exceptions to this. In some writing systems such as Chinese, there exist subsegmental graphematic relations which are not simultaneously graphemes (cf. Section 2.2.2.1). In most cases, however, *grapheme* and *smallest graphematic relation* will be synonymous.

more than one graphematic relation, with the different graphemes having different signata. Accordingly, in the German writing system, |v| can not only be used to represent /f/, but /v/ as well (cf. also Section 2.2.2.2 on allography). The complexity of these relations can be subsumed by the two naturalness parameters of transparency (cf. Section 3.3.1.4) and uniformity (cf. Section 3.3.1.5).

The linguistic level of the signatum within a given writing system is not fixed. Thus, the signata in a writing system are not necessarily consistently phonemes, syllables, or morphemes. Consider the Japanese writing system, for example, in which one script (*kanji*) is used morphographically, while two other scripts (*hiragana* and *katakana*) are used syllabically, i.e. phonographically. This kind of type mixing was also characteristic for a number of ancient writing systems, including Egyptian hieroglyphics, where morphographic writing and phonographic writing were mixed. Also, in relatively 'pure' phonographic systems such as German, we find elements such as <&> or <§> that are logographic.

In a nutshell, what the graphematic module contributes to a writing system is relations. As such, it is the vital link between languages and scripts. It stores graphematic units such as the grapheme, but also larger units such as the graphematic word, among others. Graphematics is central to this thesis as it allows evaluating the linguistic fit of writing systems: are there enough basic shapes to transparently represent all linguistic units? In general, what is the relation between basic shapes and linguistic units? Is there a one-to-one-relation, or, in naturalist terminology, is there biuniqueness? These are just some of the relevant questions that will be addressed in the context of the linguistic fit (cf. Section 3.3.1). If there is no one-to-one-relation, which is the case in most writing systems of the world, we are dealing with a situation in which there is, for example, more than one basic shape for a given phoneme. This lack of transparency is evidenced in part, for example, by the German writing system. Given these multi-basic shape-to-phoneme-correspondences (and, inversely basic shape-to-multi-phoneme-correspondences), there sometimes exist many possibilities to write a word, all licensed by a system's graphotactics, the rules of combination of written units (cf. Section 2.2.2.3). In German, *Fuchs* 'fox' could be written *<Fux>, *<Fuks>, *<Fugs>, *<Vux>, <Fuchs>, etc., not to mention the corresponding variants with initial lowercase graphemes that would ignore the capitalization of nouns. All of these spellings are found within the realm of graphematics, more specifically within the *graphematic solution space* (cf. Neef 2005, 2015), defined as the sum of possible spellings for a word licensed by a writing system. However, as indicated by the asterisks, most of these possibilities are deemed 'incorrect'. Although many of them would be understood by readers and, thus, would successfully fulfill a communicative purpose, they are considered incorrect from the perspective of a standardized norm – an orthography. They are incorrect not descriptively, but prescriptively.

(IV) Orthography is the fourth module of writing systems. Unlike the other modules, it is optional. What this also means is that the terms *writing system* and *orthography* are not synonymous. Writing systems are entire systems consisting of the modules presented here. They are theoretical reconstructions of the system underlying the actual use of writing. As such, writing systems are not prescriptive and do not single out correct spellings for words and utterances. This is only the case when they are equipped with the module of orthography which, thus, is only part of a writing system. Just like a script, an orthography is not the core part of a writing system, a role reserved for the graphematic module. It is rather imposed upon the graphematic module by external forces. More than in the context of the creation or choice of a script, the creation or negotiation of an orthography involves few of the actual actors – in this case scribes – for whom the orthography is later binding. It is rather institutions of authority that commonly make decisions about orthographic correctness. These decisions may, of course, make use of the inner systematics of a writing system, its graphematics, and can be based on the scribal practices and implicit conventions of the people using it or, in the case of orthography reforms, earlier versions of an orthography. As such, orthographies are indirectly shaped by an invisible hand (cf. Keller 2014): people's choices influence the writing system, whereby they can indirectly affect what is taken over into and codified in the standard. This is, however, as mentioned, decided directly by authorities responsible for linguistic policies.

As the orthographic module is optional, there can be writing systems without it. Diachronically, it is a relatively recent development, i.e. systems that are now equipped with an orthography have previously done without it. Communication in systems without an orthography is not automatically a problem. Depending on the level of transparency and uniformity of graphematic relations in a writing system, the graphematic solution space, i.e. possible spellings for the same utterance, might be small or large. Yet, as long as the message that the sender had intended to convey reaches the addressee relatively unscathed, communication is successful and the writing system serves its most crucial function. That being said, the orthographic module can offer advantages for communication: if it is systematic in that it makes use of regularities that already exist within the system and generalizes them, it can help render a system more natural for readers as well as writers, a function that will be discussed in the context of *Natural Orthography* (cf. Section 3.4).

Various principles are at work in an orthography. For example, the predominant unit of representation in a writing system, such as the phoneme, and, thus, its type, in this case an alphabet, can be overwritten by orthography. The German word <Kälte> 'the cold' could, for example, also be written <Kelte>, as <e> is the default grapheme for the first vowel phoneme present in the phonological representation of this word. However, in <Kelte>, there is no signal of the semantic relationship between the adjective <kalt> and the derived noun. Opting for <Kälte> because of <kalt> is a reflex of the principle of morphemic constancy. It might be initially more difficult for a beginning writer to understand why /ɛ/ is not uniformly represented as <e>, but the reader can instantly *see* and utilize the morphographic relation between the words. Both <Kelte>, which is the spelling of a different word, 'Celt', and <Kälte>, are part of the graphematic solution space for /ˈkɛltə/. It is the task of the authorities deciding on the makeup of the orthographic module to single out the (secondarily) morphographic possibility of spelling it, as in this case, whereby the morphological level of language is assigned some weight within a writing system, even if this writing system is primarily phonographic.[123]

The difference between graphematics as the constitutive module of writing systems and orthography can be summed up as follows: graphematics encapsulate everything that a writing system allows writers to do to communicate through written language. However, writing cannot only be reduced to its communicative function, making necessary a reformulation: graphematics allows writers to do whatever they intend to do with written language, which might not be reducible to communication. Orthography standardizes the possibilities and resources offered by the graphematic module. In that sense, orthography can be useful, it can also be detrimental, but, in any case, it is not obligatory. Relevant questions that pertain to the optionality of orthographies are: which writing systems have orthographies and which systems lack them? What are the crucial differences between systems that exhibit orthographies and systems that do not?

To conclude the presentation of the model, I want to mention that not only the graphematic module can be standardized by orthography. The graphetic module can also be standardized. However, graphetic standardization is commonly not externally codified like a traditional orthography, making it neither palpable nor binding. This 'ortho-graphetics' that I am referring to rather exists (or does not exist, for that matter) implicitly in the competence of writers and readers, or, to speak in purely graphetic terms, 'designers' and 'design consumers'. For example, there exists a mostly implicit convention that is, however, sometimes also explicated:[124] do not use flashy or playful typefaces or anything that could be perceived as inadequate when designing a job application. This depends on the job, of course, as flashy typefaces

123 Some call such systems *morphophonographic* (cf. DeFrancis 1989: 71; Hill 1967; cf. Section 2.3.2).

124 The fact that this convention is sometimes explicated (in guides etc.) can be seen as a sign that not everyone is expected to have the necessary knowledge about graphetic conventions or rules.

can be adequate in the fields of design, advertisement etc. A very demonstrative example of what is perceived as an 'ortho-graphetic' misstep is the widespread use of the typeface Comic Sans for all imaginable purposes. What is largely perceived as a playful typeface adequate for, among other things, invitations to children's birthday parties, is being used on gravestones, for medical reports, brochures for rape victims, etc. These uses of the typeface and similar graphetic behavior, while resisting to be labeled as traditional 'mistakes', are still perceived as such and sanctioned by a portion of the members of a literate community (cf. Meletis in press b).

2.2.1 Graphetics

Graphetics studies the materiality of writing as it investigates all phenomena and questions pertaining to the graphetic module of writing systems. As such, it is not only a subdiscipline of grapholinguistics and the material auxiliary discipline to graphematics, but also approaches questions that pertain not primarily to linguistics but to a number of other neighboring disciplines such as philosophy, didactics, neuropsychology, art history, and many more. Thus, graphetics can be broadly defined as an interdisciplinary area of research in which questions about the materiality of writing are concentrated and negotiated (cf. Meletis 2015). The research that has treated graphetic questions is scattered across different disciplines, and there is a lack of reception beyond disciplinary boundaries (cf. Spitzmüller 2016: 103). Most grapholinguistic works that have addressed graphetic questions so far have focused on *typography*, which is itself a subbranch of graphetics.

It is both striking and symptomatic that the term *graphetics* is absent from much of the literature on writing systems, let alone linguistic literature in general. Even if this appears to be the custom in (grapho-)linguistic research, this thesis will not ignore the graphetic level. Quite to the contrary: I regard the graphetic module to be just as relevant as the graphematic module. In the end, one cannot write or read if there is no visual (or tactile) material substance. Ignoring this would do the study of writing, and more specifically, the naturalness of writing, injustice. A number of recent studies underline this fact and prove that an investigation of the interplay between the graphetic and the graphematic modules is a promising endeavor (cf. Primus 2004; Fuhrhop, Buchmann & Berg 2011). A deeper understanding of the structure of scripts and other visual resources employed in writing systems can only enrich grapholinguistic research, even if it is not located within the immediate core of linguistics.

Graphetics is characterized by an often-drawn analogy with phonetics: following this view, graphetics is to graphematics what phonetics is to phonology. Like phonetics, graphetics studies language, and is thus inherently linguistic. However, it does ask questions and uses methods that are in the periphery of what is considered linguistic, with some arguing that they are in fact not linguistic.[125] Thus, similarly to a distinction made in phonetics (cf. Ladefoged 1997; Laver 2017), one could hypothetically differentiate a *linguistic graphetics* from a broader *general graphetic theory*. I will leave this question open for future discussion. Furthermore, it is paramount to note that graphetics is certainly not *only* an auxiliary discipline to graphematics, a fact that also parallels phonetics which is not merely an auxiliary discipline to phonology. In the context of grapholinguistics, graphetics and graphematics certainly go together, although their relationship is not quite symmetrical. While it is possible to conduct graphetic research without being interested in linguistic, i.e. graphematic matters, the opposite cannot be posited: Just like we usually do not do phonology without phonetics, why should we do graphematics without graphetics? Without graphetics, writing would be invisible or intangible – it simply

[125] An example is the perception of different fonts. Not only can the physiological aspect of the perception of different fonts be compared to answer questions such as *Which font is more legible?*, but due to the often connotative nature of fonts (or handwriting), the emotional response to them can also be studied (see the Comic Sans-example above or studies in which fonts are being associated with taste, cf. Section 3.2.2.3). These questions are graphetic, but it is debatable to which degree they are linguistic.

would not exist.[126] There is some truth to what linguists who disregard graphetics claim: often, it does not matter *how* writing appears, e.g. what font is used or how an individual's handwriting looks exactly. However, no one can deny that it is imperative that it *looks* at all, that it is materialized in the first place, in order to even speak of writing. The materiality of writing is not just an accidental side issue, it is constitutive of writing.

The analogy phonetics/graphetics leads also to a number of misconceptions. One of them is that graphetics studies materiality in a solely formal manner and is not concerned with functions. This characterization falls short: graphetics *is* interested also in functions, but in the functions of the substance itself rather than the functions of the linguistic information visualized by the substance. In the analysis of a product of writing, for example, graphetics does not concern itself with the denotative meaning,[127] but with the connotations that are evoked by visual features such as color, font, font size, highlighting such as bold print, italics, etc., and with the question whether an additional layer of meaning – sometimes the *crucial* layer of meaning – is served by the visual appearance of a written utterance. Consider, for example, *pseudoscripts* or *typographic mimicry* terms that denote that a typeface is designed to imitate the look of a different script (cf. Coulmas 2014: 16-19). In the examples in Figure 8, typefaces in Roman script are made to resemble (from top to bottom) Devanagari (*cafe spice*), Chinese (*Chinese takeaway*), and Arabic (*strip mall*), and this is achieved solely by the respective type design. The names themselves could be written in a prototypical font of Roman script, of course, but in that case, the specific cultural meaning evoked by the specific font design would be lost. This cultural meaning is a fundamentally graphetic matter, and in the case of these establishments, probably at least as relevant as the names and their denotative meanings.

Figure 8: Pseudoscripts, from: https://www.tdc.org/wp-content/uploads/2015/01/languagelogos.jpg (February 1st, 2018)

Some have criticized the term *graphetics* and the analogy with phonetics that it evokes, claiming that these two disciplines cannot readily be compared. One such critic is Ehlich (2001), who proposes an alternative designation, *transindividual graphology*. *Transindividual* is, I believe, self-explanatory, and graphetics as such is necessarily trans-individual, as it does not study the writing of individuals, but entire literate communities, for example. However, the

126 The word 'intangible' is included here because this claim holds also for braille writing, which works on a tactile rather than a visual level. Although sometimes, in restrictive conceptions of writing (cf. Glück 2016c: 593), braille is not regarded as a form of writing (or simply not mentioned as such), it is a representation of language in another medium, and I argue it should be counted as writing. 'Graphic', which derives etymologically from Greek *γράφω* gráphō 'scratch, carve' emphasizes this broader reading, which should not obscure the difference between tactile vs. visual, which is crucial. However, since embossed marks, as well as visual marks, are *material*, they are both studied by graphetics, which is with good reason defined as the study of the *materiality* of writing and not the study of the visuality of writing. As Spitzmüller (2016) notes, braille writing proves that writing does not necessarily have to be constituted visually. For that same reason, Harris (2005) proposes the feature of *spatiality* rather than *visuality* as a constitutive feature of writing.

127 A possible graphetic question that does concern the denotative meaning is: to what degree must graphs differ in order to be perceived and categorized as materializations of distinct basic shapes instead of as two materializations (i.e. allographs) of the same basic shape? Categorical perception at this level is a solely visual matter. However, even if the graphs differ visually to such a degree that they are in fact members of two basic shapes, the question is if one can speak of a different 'denotative meaning' since at the graphetic level, we are not concerned with the linguistic units that basic shapes represent. In fact, the assignment of basic shapes to graphemes and thus, their representation of linguistic units, is a matter of graphematics, not graphetics. That both |g| and |g| belong to the same grapheme cannot be decided on visual grounds (at least not solely), which is more obvious for the Greek pair |σ| and |ς|.

polysemous *graphology* needs to be commented on. Firstly, this term proves problematic for the simple reason that it has already been used by a quite different field that Ehlich seeks no association with, a field that studies handwriting and attempts to reconstruct psychological profiles of writers based on (visual) features of their handwriting (cf. Paul-Mengelberg 1996). While the descriptive analysis of the visual features of writing is an adequate endeavor, it is the association with psychological traits that has been overwhelmingly criticized as being unscientific (cf. Dürscheid 2016: 219f.).[128] According to Ehlich, the term *graphology*, with its suffix *-logy* as found in designations of other scientific disciplines and linguistic subbranches, whereby it establishes a direct terminological parallel to *phonology*, highlights the inner systematicity of the material subsystem of writing. What Ehlich means by systematicity is the fact that the material aspects of writing are spatially and otherwise organized in a way that allows studying them as visual systems completely without the consideration of linguistic facts. This is in contrast to phonetics, where the *meaningful* organization of sounds is not studied, which would already be a matter of phonology.[129] This lack of systematicity in phonetics is what makes the analogous term graphetics unsuitable for writing, Ehlich (2001: 65, emphasis in original) argues, claiming:

> What is termed graphetics […] should be conceived of as […] *transindividual graphology* in the same sense in which phonemics (or phonology) is used: the scope of analysis […] is to come to a *theory of scriptural form*, – i.e., its purpose is to reconstruct how, to which extent, in which ways and to which results the optical, physiological and psychological possibilities are made use of in order to establish a writing system […]. In the center of interest […] are the description and analysis of functionability and functionalizing of the objects of graphetics for establishing scriptural structure. This structure is a systematic phenomenon of its own type.

Due to the difference in medium (acoustic vs. visual), the relevant dimension for speech, and thus, phonetics, is *time*, while for writing and graphetics, it is *space* (cf. Dürscheid 2016: 32f.). The terminological analogy between the two terms, thus, works on a very abstract level, implying only that what is studied by both disciplines is the etic level, materiality, which does not deny that this level has an internal systematic structure.

Because the linguistic level is disregarded by Ehlich's proposed transindividual graphology, it would still be a complementary field to *graphematics* as defined above, the field that deals with precisely the linguistic aspects of writing. While I wholeheartedly agree with Ehlich that there is a spatially-based systematicity to the materiality of writing that speech is lacking, I do not agree that the term graphetics, on the grounds of its analogy with phonetics (rather than phonology), conceals this fact. These inner systematics of the graphetic module will be the subject of this section's remainder. Subsequently, in the discussion of the graphematic module, I will show how these graphetic systematics are linguistically functionalized. Studies by Primus (2004, 2006) and Fuhrhop (n.d.), for example, have shown that there is an inner systematicity in how lowercase basic shapes of Roman script are structured by identifying the various segments that they are composed of and unveiling the hierarchy that is evident in the arrangement of these segments.

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128 Graphology must be distinguished from *forensic handwriting examination*, which is concerned with testing the authenticity of handwritten texts, identifying the (hand)writer of texts, and determining the conditions under which a text was produced (cf. Michel 1996: 1036; Fuhrhop & Peters 2013: 185; Harralson 2013).

129 "The term 'phonology' uses the affix '-logy', and in doing so, it makes reference to the inner systematic quality of the phoneme system. I think, it is worthwhile to keep this line of thinking in the case of graphics. So I would like to propose re-introducing the term 'graphology' into the theoretical framework, as a systematically founded term. Graphology in this sense is no longer a term referring only to expression characteristics of individuals, but it is a term which refers to the inherent organized structure of writing" (Ehlich 2001: 65).

2.2.1.1 Subbranches of graphetics

Analogous to the subdivision of phonetics, three subdisciplines are assumed in graphetics. They are deducted logically from a simple model of communication, starting with production. *Productional graphetics* asks questions which pertain to the material aspects of the writing process. On the one hand, it focuses on the cognitively lower and unconscious levels of writing: which fundamental processes are involved in producing sequences of basic shapes in handwriting?[130] To also consider modern technologies, which processes are involved when typing on a keyboard or swiping on a touchscreen? These questions are primarily of physiological and psycholinguistic nature. An example of applied productional-graphetic research is the study of *character amnesia* in Chinese (cf. Xu 2015), a situation in which people forget how to handwrite specific characters that they could formerly write. Interestingly, in many cases, people are still able to read these characters, implying that reading and writing processes are to some degree independent of one another (cf. Section 3.2.2.2).[131] On the other hand, choices which are located at higher and conscious levels of production and yet are concerned with visual aspects are also studied by productional graphetics: from a sociolinguistic perspective, for example, questions can be asked about the writer's motivation to choose a specific font or a specific form of highlighting (**bold** instead of *italics* or underlining, etc.). Choices on all levels of writing, including the material, are – to some degree – "acts of identity" (cf. Hatcher 2008), whether they are conscious or unconscious. What was the writer's intention in designing a text in a specific way, and was it motivated socio-culturally – if so, how? Does a text's producer want its graphetics to convey membership of or distance from a certain social group? Ultimately, all of the questions that are asked in graphematics can be studied here as well – just on another level, the material.

The second subbranch of graphetics is likely the most 'traditionally' linguistic one in that it is solely descriptive. *Script-graphetics* or *descriptive graphetics* (from German *Skriptgraphetik*, cf. Meletis 2015: 42f., Fuhrhop & Peters 2013: 183) visually analyzes products of writing divorced from the processes of production and perception. This, however, does not mean that a descriptive analysis cannot occasionally spawn questions pertaining to other graphetic subdisciplines as well, for example on how the production and the involved surfaces and instruments could have affected the visual shape of a product of writing. This question of *why* a product of writing appears the way it does is indeed of relevance. A demonstrative example comes in the form of the visual appearance of an entire script: the Burmese script, which is, in Burmese, also referred to as *ca-lonh* 'round script' (cf. Coulmas 1996a: 55; Watkins 2009: 170; cf. Figure 9), is so visually round in nature because it was traditionally written on palm leaves. These leaves' fibers are linear, which is why angular basic shapes would have caused them to rip. In regarding these issues, script-graphetics is similar to neighboring, predominantly historically oriented disciplines such as paleography and epigraphy. They are, in this understanding, specialized subdisciplines of descriptive graphetics. The different levels of graphetics that are presented below in the cartography of the writing surface (cf. Section 2.2.1.2) are based on a description of the spatial arrangement of writing and are, thus, themselves a product of a script-graphetic analysis.

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130 Movements in handwriting are studied by a field called *graphonomics*. This term was coined in the 1980's and defines a "multidisciplinary emerging field focused on handwriting and drawing movements" that has made an "important contribution to the field of motor behavior by developing models aimed to conceptualize the production of fine motor movements using graphical tools" (van Gemmert & Contreras-Vidal 2015: 165). Because *graphonomics* also concerns itself with the production of non-linguistic graphic material, it cannot be seen as a graphetic subdiscipline, although there is certainly a great deal of overlap between them.

131 Another striking example of this is *pure alexia*, also referred to as *alexia without agraphia*. People who suffer from this condition have lost their reading abilities, while visual recognition in general and writing skills are preserved (cf. Rupareliya, Naqvi & Hejazi 2017). Hence, a person can write something, but even immediately after, the person is not able to read what they have just written – a reflection that in the brain, regions that are responsible for reading can be impaired, while regions for writing are not affected.

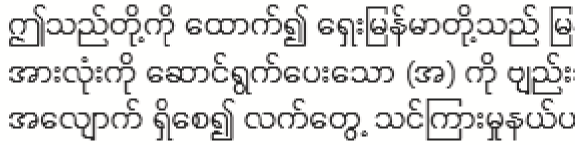
ဤသည်တို့ကို ထောက်၍ ရှေးမြန်မာတို့သည် မြ
အားလုံးကို ဆောင်ရွက်ပေးသော (အ) ကို ဗျည်း
အလျောက် ရှိစေ၍ လက်တွေ့ သင်ကြားမှုနယ်ပ

Figure 9: Extract from the Burmese Wikipedia page covering the Burmese writing system

The third and final subbranch, arguably the most prominent of the three, is *perceptual graphetics*. Similar to productional graphetics, it is not predominantly a linguistic subfield, but rather one that is enriched by research from psychology, cognitive science, neurobiology, and other fields. It is concerned mainly with the processes of perception, recognition and – at the highest level – reading.[132] How is a basic shape or a word that is itself made up of a sequence of basic shapes recognized? On a higher – but not necessarily conscious – level, sociolinguistic questions can be asked, symmetrical to the questions studied by productional graphetics: what emotions are evoked in the perception of different typefaces? What connotations do typefaces carry? What is the attitude towards a specific style of writing (a specific typeface, handwriting)? A striking example of the importance and the reality of a sociolinguistic perceptual graphetics was already mentioned above: the passionate discourse about the typeface Comic Sans, especially in the realm of the internet (cf. Meletis in press b). This is largely a sociolinguistic issue, but since it has at its core the materiality of writing, it is also a matter of graphetics.

All three subbranches of graphetics are central to this thesis. In the first step of describing a writing system, its graphetic resources must be identified and characterized. As mentioned, this is a fundamentally script-graphetic matter. In a second step, questions about graphetic naturalness should be asked, which will be done in the proposal of a Natural Graphetics (Section 3.2). Here, productional as well as perceptual aspects will come to the fore. As in the analysis of the graphematic module of writing systems, external evidence has to be considered: literacy acquisition, the history, development and change of scripts and scribal practices, the on-line processing in reading and writing, and also the loss, malfunction and generally disorders of these processes that are located at the material level of writing. All these types of external evidence will hopefully coalesce with the descriptive graphetic account to reveal what the more natural and the more unnatural features of scripts are. As a result, conclusions can be drawn and suggestions can be made for typographic practice, for designing fonts for dyslexic readers or beginning readers, etc.

2.2.1.2 Cartography of the surface: Graphetic levels and units

The levels and units that will be presented here are constituted visually by "spaces of nothing" between them: I call these spaces *empty spaces*. Graphetic units are to a large degree universal, but they can differ across writing systems based on where these empty spaces are found. The fact that graphetic (and, in turn, some graphematic) units are constituted by empty spaces is the core of the *empty space criterion*. It is fundamentally based on the gestalt theoretical principle of *figure—ground*, which was also reinterpreted as a semiotic parameter in NM (cf. Section 1.3.2). A crucial theoretical question is whether in some cases, graphetic units are only secondarily graphetic, when empty spaces – as will be shown for the word in some writing systems – are determined by linguistic units. Or could the inverse be true, and graphetic units constitute linguistic units through their visualization? This is the graphetic/graphematic chicken-and-egg-problem that Spitzmüller (2016: 108, my translation) addresses when he asks "whether the text

[132] Reading, of course, already involves the linguistic level, and as such, reading processes cannot be treated solely by perceptual graphetics. For the study of reading, graphetic, graphematic, and psychological questions merge to what is essentially psycholinguistic research. What I want to underline here is the specific contribution that *perceptual graphetics* makes to this research by studying the material aspects of reading processes, although these are anyhow often ignored.

form merely makes *visible* an already existing informational structure or whether it itself *creates* its own informational structures".[133] The circumstances under which both of these options can be accurate will be addressed in the discussion of graphematic units.

The smallest empty space in most graphetic modules is the empty space between basic shapes, as evidenced by Roman script – provided it is materialized in a typeface with spaces or spaced handwriting and not in cursive handwriting or some decorative typeface in which graphs are connected. In Arabic, on the other hand, there is no empty space between most of the segmental basic shapes (cf. Section 2.2.2.2), as they are connected to each other, even in print. As illustrated in Figure 10, different types of empty spaces constitute different spaces of written substance. Spaces that are of universal nature are the *segmental space*, the *linear space*, the *areal space*, and the *holistic space* (cf. Bredel 2008, 2011; Meletis 2015: 115). These spaces are studied by *micro-*, *meso-* and *macrographetics*.[134] Following Reißig (2015), I term the practice of dividing the overall writing surface in subspaces of different hierarchical levels *cartography*. Notably, the concatenation of spaces from a lower level constitutes spaces at a higher level: the *strict layer hypothesis*,[135] which Evertz (2016) invokes in the context of a suprasegmental graphematic model (cf. Section 2.2.2.3), applies to graphetics, as well. Every holistic space is necessarily made up of areal spaces, which are made up of linear spaces, which are made up of segmental spaces.

Figure 10: Cartography of the writing surface: empty spaces and the graphetic levels and units they constitute, adapted from Meletis (2015: 116)

[133] „[…] ob die Textgestalt lediglich eine bereits vorhandene Informationsstruktur von Texten *sichtbar* macht oder ob sie selbst eigene Informationsstrukturen *schafft*" (emphasis in original).

[134] These terms are adaptations of Stöckl's (2004) terminology of typography (micro-, meso-, macro- and paratypography). By substituting 'typography' with 'graphetics' (cf. Meletis 2015: 119), the terms are broadened, which reflects that typography is just a part of graphetics. Typography is concerned with the printed – and nowadays, digital – word, while it does not deal with chirography, i.e. handwriting (unless handwriting is mimicked by typefaces, but even then, it is still digital and/or printed). Both of these fields – typo- as well as chirography – are subjects of graphetics.

[135] The original formulation of this hypothesis – proposed for phonology – reads as follows: "We have proposed that a category of level *i* in the hierarchy immediately dominates a (sequence of) categories of level *i-1*" (Selkirk 1984: 26, emphasis in original).

1. Micrographetics: elementary forms, graphs, basic shapes

The smallest space in which a graphetic unit is produced is the *segmental space*. This space and all the questions pertaining to it are studied by *micrographetics*. The central units at this level are the abstract *basic shape* and its concrete realization, the *graph*. Depending on the script in question, *elementary forms* – segments of basic shapes – can also be of relevance (see below). Each basic shape fills its own segmental space. This marks one of the central differences between speech and writing: in writing, utterances already come segmented. What readers perceive is units which are made discrete by empty spaces between them. In speech, by contrast, segmentation is a sophisticated task. There is a lively debate around the claim that what is perceptually salient in spoken language is actually neither segments nor (phonological) words, but syllables (cf. for a summary of this discussion Massaro 2011; Daniels 1992 discusses the relevance of this claim for writing; cf. Section 3.3.2.1). Of course, on a graphematic level, a single basic shape occupying a segmental space can be in a graphematic relation with a syllable (more specifically, a mora), as is the case in Japanese kana, for example: here, segmental graphetic and in turn segmental graphematic units stand for a polysegmental phonological unit, such as <ぬ> which represents /nu/. However, in the graphetic module, graphematic relations are not of concern (for a discussion of the graphematic/phonological syllable in Japanese, cf. Section 2.2.2.3). To summarize, the fundamental perceptual difference between speech and writing is the fact that the most salient visual unit is segmental (with exceptions like cursive handwriting or Arabic script),[136] while the most salient acoustic unit is likely not segmental.

Basic shapes, as the smallest *units*, are commonly complex, as they are made up[137] of segments themselves. In German-speaking grapholinguistics, these are sometimes referred to as elementary forms (*Elementarformen*, cf. Berkemeier 1997: 242; Butt & Eisenberg 1990: 36; Meletis 2015: 65-66). These elementary forms have been the matter of controversial debate, as some opt to treat basic shapes as holistic and thus do not break them down into smaller parts, claiming that such a segmentation is not of value, at least not for graphematics (cf. Neef 2005; Rezec 2009: 81; Wehde 2000: 74; Brekle 1994b: 171). Other researchers, however, have in various contexts used different methods to attempt a dissection of these shapes into smaller elementary forms. Such efforts have come from psycholinguistics, cognitive science, semiotics, didactics, and, notably, linguistics (cf. an overview in Meletis 2015: 50-79). The elementary forms that are assumed in most segmentations are a (straight) line, a curve, and a dot – together, these constitute the (graphetic) *formative lexicon* (cf. Butt & Eisenberg 1990: 36). Quite trivially, it appears logical that every basic shape in the scripts of the world is made up of these three components. However, the story is more sophisticated than that: for example, Primus, Fuhrhop, and other linguists have convincingly shown that there are some inner systematics to lowercase Roman basic shapes as well as basic shapes from the Tifinagh and the Arabic scripts (cf. Primus 2004, 2006; Primus & Wagner 2013; Fuhrhop n.d.).

The basic shape is not only the central unit of micrographetics, but the central unit of graphetics in general. In this assumption, I follow Rezec (2009, 2013), who proposed that the grapheme should be rid of its duty to serve both as a material and a linguistic unit. As briefly established above and extensively elaborated below (cf. Section 2.2.2.1), I conceive of the grapheme as a semiotic sign constituted by a visual unit and a linguistic unit. Both of these units are

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[136] These examples are to be taken with a grain of salt. Perceptually, and thus, descriptively, there might not be any spaces between the graphs of a word written in Arabic script or between the graphs in connected handwriting. In production, too, sequences of graphs are often written in a continuous flow, lacking segmentation. However, even writers of connected scripts are aware of the segmental basis of writing. For example, basic shapes are taught as separate units in literacy instruction, and I argue that they are fundamentally stored and used as such. Segmenting a connected written word of Arabic into its respective basic shapes should thus not be a problem since it was conceptually and consciously composed of these segments.

[137] Exceptions are single elementary forms that are simultaneously non-segmentable basic shapes, such as |.| or |–| or |c|.

parts of a grapheme. For this reason, the grapheme cannot simultaneously *be* the visual unit that is only part of it. It can be and in fact *is*, however, a visible *sign* relating the visual unit with a linguistic unit. Thus, when I speak of graphemes, I do not mean material visual shapes, but only visual signs with a linguistic value. Rezec managed to divorce these functions allocated to the grapheme (1. being a visual unit; 2. being the smallest distinctive unit of writing; 3. corresponding to a phoneme) by assigning the first function to the so-called basic shape (originally *Grundform* in German). The basic shape is material. However, at the same time, it is abstract. It represents a bundle of visual features that are necessary to visually distinguish a shape from other shapes in an inventory. As Herrick (1974: 11) defined it long before Rezec: "The basic shape […] is itself an abstract […] unit; it is a group of geometrical distinctive features which a written mark must have so that a literate person will recognize it as an embodiment of a certain *letter* [= to be read as *grapheme* in my conception, D.M.]". What differentiates |E| from |F|, for example, is the number of segments they consist of. What differentiates |X| from |T| is not the number or nature of segments – in both cases it is two straight lines – but the position of these segments and, most crucially, the spatial and topological relation between them within the segmental space. |J| and |L| are distinguished by the nature of one segment – a bow in |J| vs. a straight line in |L| –, which also influences the transition between the two segments, respectively, as well as the orientation of this lower horizontal segment (leftwards in |J|, rightwards in |L|). This measure of visual distance between two basic shapes can be termed their *graphetic distance*.

The linear space (see below) and with it, the space it subsumes, the segmental space, can be divided further. When four horizontal division lines are drawn, the linear space can be divided into three spaces that are vertically superimposed upon each other (cf. Althaus 1973; see Figure 11).[138] The topmost of these spaces is the *high space*, followed by the *central space* in the middle, and the *low space* at the bottom. The third of the division lines – the one the basic shapes 'stand on' – is commonly also referred to as the *base line*. This division of the linear/segmental space helps describe how exactly basic shapes, at least those of Roman script, occupy the segmental space. Of great relevance, as we will see, are the parts of basic shapes that extend beyond the central space, which is filled by a basic shape such as |o|: following typographic terminology, these extending parts are called *ascenders* if they occupy the high space, as in |d|, and *descenders* if they occupy the low space, as in |y|.

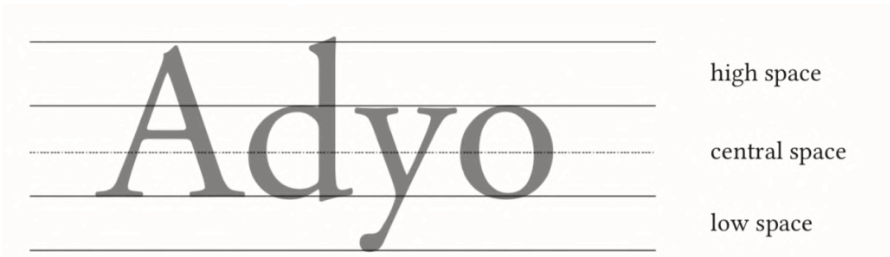

Figure 11: Four-space schema of the segmental/linear space in Roman script

Notably, this specific spatial division of the linear space is by no means universal.[139] Quite to the contrary, even if it applies to a number of scripts, it is fairly script-specific. For Japanese *kanji* and the Chinese *hanzi* that they are based on, for example, there exist multiple divisions of the segmental space into smaller subspaces (cf. Figure 12), depending on how the subseg-

[138] Alternatively, as visualized in Figure 11 by the dotted line in the middle of the central space, the linear space can be segmented into four vertical spaces that are divided by five lines. This four-space schema (German *Vierlinienschema*) represented the original conception (cf. Althaus 1973). In the more modern three-space schema (cf. Domahs & Primus 2015: 133), the middle two spaces of the four-space schema are subsumed as one space, the central space (cf. Primus & Wagner 2013: 42).

[139] In Thai script, for example, there are two additional spaces above the high space and an additional space below the low space, proving that the spatial subdivision of the segmental space often comes with script-specific idiosyncrasies.

mental elements of basic shapes are arranged. Because of these different ways of dividing the segmental space, the segmentation in the Chinese script and Japanese kanji does not extend over the linear space, i.e. every segmental space must be subsegmented individually. A characterization of every possible segmentation of the segmental/linear spaces – complete with the identification of elementary forms and their arrangement into basic shapes – is beyond the scope of this thesis, but it is an endeavor that will need to be dealt with in detailed analyses of scripts and writing systems (cf. Section 3.2.1).

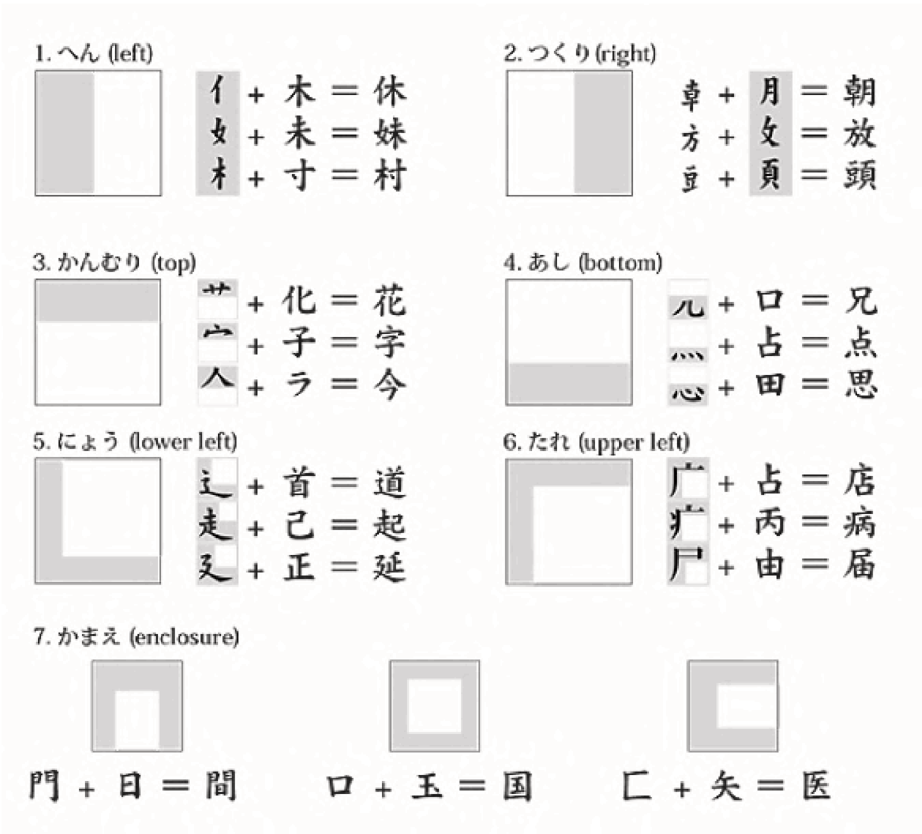

Figure 12: Different placements of subsegmental components within the segmental space in Japanese kanji with examples, from: http://jpfsyd-classroomresources.com/r44.html (February 11th, 2018)

So far, I have only mentioned the units that different *scripts* (Roman, Chinese, Japanese kana) offer as basic shapes. However, writing systems make use of more kinds of visual material than just scriptual units. Consider digits such as |2| or special characters like |$|, not to mention punctuation marks such as |?| which are all elements of a larger group Rezec (2009: 33) calls *non-letters* (German *Nichtbuchstaben*). Because graphetic research – as established above – is sometimes located at the periphery of linguistics, and since the definition of basic shape is still underspecified in this respect, technically, all of these units should be regarded as basic shapes. The question, now, is how it can be established that they belong to different classes. As I have argued elsewhere (Meletis 2015: 124f.), visually, there is no clear way to distinguish them: by simply describing individual basic shapes such as |Z| and |2| and |§| visually, one cannot *see* that they belong to different classes. While individual basic shapes cannot be categorized, their classes can be evaluated with the help of a mixture of graphetic, graphematic, and graphotactic features, as Bredel (2011: 9) has shown.

Table 1: Classes of basic shapes evaluated with graphetic, graphematic, and graphotactic features, from Bredel (2008: 23)

	diacritics	**letters**	**digits**	**special characters**	**punctuation marks**	**empty spaces**
identifiable without context	+	+	+	+	+	–
recodable	–	+	+	+	–	–
combinable	–	+	+	–	–	–
paired	–	+	–	–	–	–
additive	+	–	–	–	–	–

Bredel proposes four features for the distinction of different classes of segmental graphetic material that is used in the German writing system: letters, digits, special characters, punctuation marks, and empty spaces (and, in an earlier work, diacritics). The features are (1) *context-free identification*, (2) *recodability*, (3) *combinability*, (4) *paired variants*, and (5) *additive* (cf. Table 1). Feature (1) is graphetic, as it can be determined visually, feature (2) is graphematic, as it involves the linguistic units that the basic shapes are in relations with, feature (3) is graphotactic, and feature (4) is, depending on the view, graphematic, since there is often no visual similarity between the upper- and lowercase basic shapes (e.g. |A| and |a|) and they are just paired according to their linguistic reference, or conventional, when the pairing of corresponding upper- and lowercase basic shapes is treated as a convention. The only class of graphetic material that is not identifiable without context is empty spaces, as they are made visible only by non-empty material around them. The only of these features that punctuation exhibits is that it is identifiable without context. Punctuation does not display any of the other features: it is not verbally recodable, which means it cannot be 'verbalized' or 'read' the way the grapheme <b> can be read as [b] or the special character <%> can be read as [pɜɹ'sɛnt].[140] Furthermore, punctuation marks cannot combine with each other – the ellipsis <…> is interpreted as one mark, and while there are exceptions such as <?!>, punctuation marks do not combine freely with one another to form new units the way digits or letters do, as in <27> or <twenty-seven>. Lastly, punctuation marks (as well as digits, special characters, and empty spaces) are, unlike letters, not available in two different variants: letters are, at least in Roman script which Bredel's work focuses on, available in lower- and uppercase variants,[141] whereas punctuation marks are not. It must be added that these features have not been tested for the graphetic module of other writing systems than German, but it is expected that they hold for all alphabetic writing systems that have a case distinction and upper- and lowercase inventories.

At a later point, I will argue that terms such as *letter* or *character* are not appropriate when used as designations for language-specific graphemes, i.e. linguistic units. *Letter* is currently being used in this way for many systems (not only for alphabets but also abjads), while *character* is strongly connected to the Chinese system as well as systems that have developed from it. This use, however, is misleading, and it obscures the relevant features that graphemes of different writing systems share (cf. Section 2.2.2.1). Instead, I think of terms such as *letter* and *character* as graphetic terms that by convention designate classes of basic shapes in certain scripts. For some scripts, there might not even be terms such as *letter* or *character*, which is when *basic shape* proves useful. Due to the lack of universal heuristics that allow distinguishing

140 This feature determines that the slash </> is no punctuation mark – at least not in German – as it can be verbalized (cf. Bredel 2009: 119). An example is one possible way of writing genderwise correctly in German, <Student/innen>, which is to be read as <Studenten *und* Studentinnen> 'male students *and* female students'.

141 Most other scripts and in turn writing systems do not have this distinction between upper- and lowercase basic shapes. In these writing systems, thus, there might be no feature distinguishing digits from 'letters'.

different classes of basic shapes the way Bredel's (2011) criteria allow for German, I argue that what is vital is knowledge about these categories that works *top-down* and makes possible categorizations (cf. Meletis 2015: 124f.). When they are proficient in a writing system, readers and writers *know* what class a given basic shape belongs to.[142] As there is no visual coherence within the classes to tell them apart, this is *graphematic* knowledge.[143] To summarize, *basic shape* is generally an underspecified term that designates all visual units used in a writing system. However, since in this thesis is primarily concerned with basic shapes of the type *letter* or *character*, i.e. basic shapes that are the visual parts of prototypical graphemes in a writing system, my unmarked use of *basic shape* is restrictive and means only them. A possible, though flawed specific term could be *scriptual basic shape*,[144] insinuating that these basic shapes are part of a script inventory, whereas digits, punctuation marks, and special characters are not. This is also reflected by the fact that these latter classes are used across many writing systems regardless of the scripts these systems use. Thus, when I wish to refer to the other classes of basic shapes – digits, special characters, punctuation marks – I will do so explicitly.

While the assignment of basic shapes to classes is not a visual, and thus, not a graphetic matter, the differentiation between different individual (scriptual) basic shapes is. Thus, |F| and |E| are different basic shapes solely for the reason that they differ visually, and not because they usually represent different linguistic units and therefore, are parts of distinct graphemes. Vice versa, visually distinct and thus separate basic shapes such as |ς| vs. |σ| can be assigned to the same grapheme. They are allographs (cf. Section 2.2.2.2). Thus, the abstract visual information stored in a basic shape – a visual common denominator – is distinctive.

However, the abstractness of the distinctive visual information leaves a lot of leeway for graphetic variation: the 'visual skeleton' that constitutes the basic shape can be materialized in countless different ways (cf. Figure 13). This explains how, for example, units in different handwritings or different typefaces that each have their specific visual character are perceived as 'different' but can still be identified and assigned to respective basic shapes. This is due to the fact that the human visual and cognitive systems allow us to recognize *graphs* that look different and categorically assign them to the same basic shape as long as they are within the graphetic solution space (see below), i.e. do not resemble another basic shape that is possibly part of a different graphematic relation, or a shape that is not a basic shape at all. This leads to a necessary definition of the unit at the lowest level of writing, the *graph*.

A single grapheme can be visually represented by different basic shapes, and a single basic shape can be visually materialized by myriad graphs. While the basic shape is an abstract mental unit, the *graph*[145] is its concrete realization (cf. Adam 2013). As such, every graph is a

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142 It is also this knowledge that tells the reader if an element belongs to one of the classes of basic shapes or not, or in other words, if something even is a *basic shape* of a writing system, i.e. writing, or if it is a drawing, a scribble, or a sign (such as an emoji, for example) that is not part of the writing system *proper*.

143 A part of it might be graphetic knowledge, too, as scripts are visual systems with specific characteristics: 'letters' of the Roman script, for example, have their coda prototypically on the right side – |b| or |D| – while digits prototypically lean to the left: |3| or |9| (cf. Sections 3.2.1 and 3.2.2.1).

144 This term highlights the fact that these basic shapes are elements of a *script*, a (most often) closed system. It is more general than the script-specific designations *letter*, *character*, etc. It also avoids mixing the linguistic and the material level, which not only the script-specific designations but also alternative proposals such as *graphematic basic shapes* do. However, it is an undeniable fact that these scriptual basic shapes are the ones that are used to embody the central graphemes of a writing system, while other basic shapes – digits, special characters, and punctuation marks, whose designations are also flawed since they are derived from their functions – are peripheral. Note, however, that the term *scriptual basic shape* is suboptimal insofar as these sets or inventories of other classes of basic shapes, e.g. the set of digits, could also be treated as scripts – however, these sets or 'scripts' in the broader sense are not constitutive writing systems.

145 Sometimes, the alternative designation *glyph* is used, a term borrowed from typography (cf. Neef 2015: 711). *Graph* and *glyph* can be considered synonyms.

unique physical event. Also, every graph is always an allograph, as it is only one of countless possible realizations of the same basic shape. As it represents the concrete visual level, the level of graphs is the scope of all visual variation in writing. As Ludwig (2007: 382) remarks, there are (seemingly) no limits to this variation. Indeed, as long as the abstract visual features of a basic shape – number of segments, arrangement of segments in space and topological configuration of segments with respect to each other, among others – are kept relatively constant, everything else can vary.

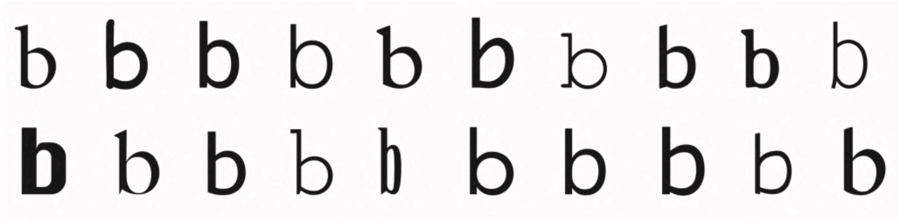

Figure 13: Basic shape |b| materialized as twenty different graphs in different typefaces

To illustrate this, consider Figure 14, in which the basic shape |A| is materialized as a prototypical graph (left) and two other versions in which different visual features have been distorted. While the middle graph, in which the relative length of the segments has been altered, is still recognizable as a realization of |A|, the rightmost version, in which the topological configuration of elements was changed drastically, is possibly too distorted to recognize as |A|.

Figure 14: Geometrical vs. topological distortion of a prototypical basic shape, from Meletis (2015: 164)

In analogy to Neef's graphematic solution space, I propose a *graphetic solution space*. The licensed variation manifested by graphs that are still assigned to the same basic shape is located *within* the boundaries of a basic shape's graphetic solution space. Thus, the graphetic solution space is the theoretical counterpart of what makes possible visual categorical perception and, for that matter, optical character recognition (OCR). The variants within this space may differ only very subtly. As Hamp (1959: 2) remarked, "[m]any of these [typefaces, D.M.] are characterized in such subtle ways that the average person is not aware of their individuality as such". But even if a person *is* aware of the individuality of graphs within the graphetic solution space, the differences between them are non-distinctive.

A concept central to the graphetic solution space is *graphetic distance*. The graphetic solution space for a given basic shape includes all the graphs – as concrete materializations of the abstract basic shape – that are visually categorized as being members of that basic shape. This graphetic solution space is crucially dependent on both the script as the visual system that the basic shape is a part of as well as the writing system (as a linguistic semiotic system) that employs this script. The boundaries of the graphetic solution space, thus, are determined graphematically, in other words: not visually, but linguistically. In Greek script as used for the Modern Greek writing system, for example, there is a categorical distinction between the basic shapes |T| and |Γ| since they are part of distinct graphemes, meaning they are used to refer to different linguistic units. Thus, the graphetic solution space for them will not be as large and as 'forgiving' as the solution space might be for |T| in Roman script as used by many alphabetic writing systems (cf. Figure 15 for the graphetic solution space of |T| in Greek). In the latter, the basic shape |Γ| does not exist, and thus, it is not graphematically associated with any linguistic unit. Therefore, in Roman script, the graphetic solution space for |T| is larger since there is no danger of mistaking it for |Γ|. From this also follows that it is impossible to assume "distinctive features” of a script with purely graphetic means, as what is visually distinctive relies on what is distinctive graphematically. This also means that a given feature might be distinctive in a script used by a specific writing system in some instances and non-distinctive in others. Accordingly, neither script-internally nor universally, i.e. across scripts, is there a way to determine an inventory of distinctive features of basic shapes. Distinctions are only meaningful if any two basic shapes of a script and their relationship with each other are considered, e.g. |Τ| and |Γ| in Modern Greek. The length and/or position of the upper stroke is distinctive in this case, but the same features might not be distinctive in any other two basic shapes of the same script.

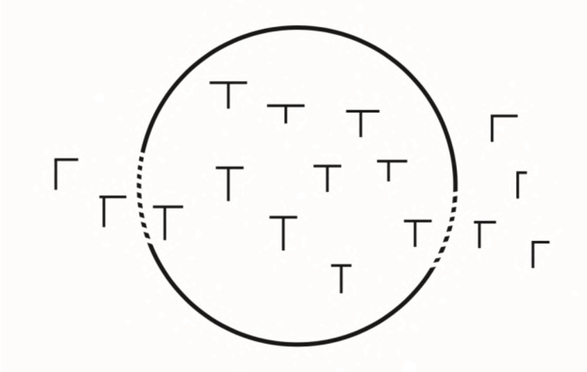

Figure 15: Graphetic solution space for |Τ| in Greek

Graphematics only imposes boundaries onto the graphetic solution space(s) in a top-down matter in cases in which visually, graphs are getting too similar to the appearance of a distinct basic shape and this similarity could, on a graphematic level, lead to a wrong categorization. Inversely, there also exist visual distinctions in the graphetic solution space that do not correspond to graphematic distinctions and are, thus, independent of graphematics: take |g| vs. |ɡ| (cf. also Section 2.2.2.2 on allography). In this case, there is a visual distinction between the basic shapes. This might be hard to perceive for us since we *know* that they both ‘mean’ the same, i.e. represent the same unit, and when asked, we might not even know that two variants exist (cf. Section 3.2.2.2). Here, the visual distinction does not correspond with a graphematic distinction. However, because of the visual dissimilarity, and possibly because of the top-down conventional knowledge that both are existing variants of one abstract unit, |g| vs. |ɡ| are distinct basic shapes, as are |A| and |a|, for example. Note that what has been said concerns the perception and recognition of individual, isolated basic shapes. In the context of a sequence of basic shapes in a graphematic word, such as <ΛCCESS>, even major distortions such as the omission of segments as in |Λ| for |A| might be forgiven because the context offers disambiguating information – which corresponds with how perception is modeled in the influential *Interactive Activation Model* (cf. McClelland & Rumelhart 1981; cf. Section 3.2.2.3). Larger contexts are exactly what we are going to be looking at next.

When basic shapes (or better: concrete graphs) are produced next to each other, each of them occupies its own segmental space,[146] and they are written in a row, whether horizontally from left to right or right to left or vertically from top to bottom or bottom to top. These ‘rows’ lead to the first polysegmental level of writing: the linear space, which is at the center of mesographetics.

2. Mesographetics: one-dimensional graphetic sequence, line

Two graphetic units occupy the linear space and are part of the mesographetic level. They are distinguished from each other in that they are constituted by different empty spaces. Also, one of them fills only part of the linear space while the other fills all of the available linear space. The first of these units is the *one-dimensional graphetic sequence*, the second the *line*. While the one-dimensional graphetic sequence is, in most cases, a graphetic unit only secondarily, as it is frequently determined by the graphematic level, specifically by graphematic words (but also larger units such as graphematic sentences), the line is a purely graphetic unit with only a few exceptions.

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146 However, sometimes, they are ‘shrunk’ in size and become elementary forms themselves, occupying segmental spaces only together with other ‘shrunk’ basic shapes, as in Chinese.

The one-dimensional graphetic sequence only exists in writing systems in which there are spaces either between words or sentences.[147] The latter is the case in Thai, for example, where, due to the lack of empty spaces between words, one-dimensional graphetic sequences correspond with syntactic units. In all of the writing systems using (a modified version of) Roman script, the one-dimensional graphetic sequence usually makes discernable words on a graphematic level. However, it is crucial to note that a correspondence with the lexical or morphosyntactic meaning of 'word' or 'sentence' is not required for the definition of the one-dimensional graphetic sequence, it is an independent graphetic unit: everything that stands between two empty spaces of this level and consists of at least two basic shapes (= occupying two segmental spaces) regardless of their class qualifies as a one-dimensional graphetic sequence. This means that in alphabets, basic shapes such as, for example, punctuation marks – whether on the word-level such as <'> or the sentence-level such as <!> – that are enclitically attached to other basic shapes, are parts of one-dimensional graphetic sequences. Thus, at the end of the preceding sentence, |sequence.| is a one-dimensional graphetic sequence, and in the preceding phrase, |sequence,| is a one-dimensional graphetic sequence. Visually, in these cases, there are no larger spaces between (scriptual) basic shapes and punctuation marks than between a (scriptual) basic shape and a different (scriptual) basic shape. Note that these units are not graphematic words, as (sentence-final) periods and commas are not part of graphematic words (cf. Section 2.2.2.4). One-dimensional graphetic sequences and graphematic words are also incongruous in cases in which graphematic words consist only of one simple grapheme, such as the article <a> in English or the conjunction <y> 'and' in Spanish. These units occupy only one segmental space and are, thus, no one-dimensional graphetic sequences.

The other unit that extends in the linear space is the line. It meets the empty space criterion as it is made visible by the *line break*. Lines are constituted by the fact that on many surfaces, scribes eventually reach the physical boundary of the writing surface. Reaching the edge commands that one continues writing a little bit lower (in horizontal top-down writing systems) and returns to the beginning of the surface (whether that is left or right). The line is commonly not functionalized as a graphematic unit the way the one-dimensional graphetic sequence is for words and sentences. It *can* be used as a linguistic unit in the sense of a loose semantic unit, if one considers verses in poetry, which, however, commonly only occupy a small part of the linear space. Notably, line breaks can be intentional, for example in typography, where they are sometimes aesthetically motivated. In this case, line breaks are conscious choices made by the writer/designer[148] that have nothing to do with the physical boundaries of the surface. Verses or aesthetically motivated lines, of course, are not the default types of lines.

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[147] Previously, in a script-graphetic analysis of the visual material used in the German writing system, I termed this unit 'graphic word' (cf. Meletis 2015: 130-132). This is problematic since, on one hand, it mixes the graphematic and the graphetic levels of description. Even if the one-dimensional graphetic sequence corresponds largely with 'words' (however one defines that linguistic unit or category), this correspondence cannot be constitutive for graphetic units. On the other hand, a term such as 'graphic word' is inherently specific. It cannot be used for writing systems in which one-dimensional graphetic sequences do not correspond with words, but with other linguistic units. Instead of assuming different units such as 'graph(et)ic word' and 'graphetic sentence' based on their correlations – which will be done in graphematics – we are only concerned with the visual features of the units at this point. The common visual denominator of these units regardless of any linguistic correspondence is that basic shapes that occupy segmental spaces are produced in a non-spaced sequence. This sequence occupies a linear space.

[148] Ludwig (2007: 377) notes that in the past, the tasks of writing a text and designing it were undertaken by different people with different professions. Even though many people nowadays work with word processing programs and not only write but also format their own written products, these tasks are in many contexts still separated today. Authors who hand in manuscripts of their books to a publisher, for example, often do not participate in the formatting process (at least not the final, professional formatting process). These different tasks and the associated professions also reflect the underlying distinction between graphetics and graphematics.

3. Macrographetics: two-dimensional graphetic sequence, page/layout

The spatially highest level of graphetics is macrographetics. When linear spaces are concatenated either horizontally or vertically, but necessarily in the different dimension than the concatenation of segmental spaces, these clusters of lines constitute *two-dimensional graphetic sequences* that occupy areal spaces. The empty space making them visible is located between them. Two-dimensional graphetic sequences can be functionalized differently, for example as paragraphs or columns. These, however, are not graphetic categories, since for the assumption of graphetic categories, visual criteria must suffice, and it is debatable how paragraphs and columns can be distinguished by visual means. A possible answer is that in columns, in horizontally written writing systems, lines commonly do not fill all of the linear space on the 'page' (see below), but only part of it, while in paragraphs, they prototypically fill most or all of the linear space. Also, columns, as two-dimensional spaces, are concatenated next to each other on the horizontal axis, and not like paragraphs below each other.

The next 'unit' is constituted by the arrangement of two-dimensional graphetic sequences as well as other visual material such as figures, pictures etc. on the entirety of a surface. If the surface is a page on which two paragraphs, a few footnotes (paragraphs at the bottom of the page, usually in smaller print) and maybe a figure or a table are printed, these are all elements that are arranged in the so-called *holistic space*. The arrangement of elements in the holistic space is commonly referred to as *layout*. Holistic spaces are not just pages or double pages, which are often perceived simultaneously when reading a book, but any spaces that can be perceived at once, which also includes, for example, the section of a website that is currently displayed on a screen or a wall on which a Powerpoint slide is being projected. When scrolling up or down, the holistic space changes. In this sense, holistic spaces are dynamic and determined by what is perceived by readers as a "whole" space. The page is only the prototypical analog version of it.

A phenomenon functioning at the macrographetic level is *typographic dispositifs* (cf. Wehde 2000), which could be more generally termed *graphetic dispositifs*. If the arrangement of elements on a page immediately allows the reader, or simply the perceiver, since the meaning of the text is not of relevance at this point, to identify the genre of a product of writing, it functions as a graphetic dispositif. If a text is designed rather prototypically, it is easily recognizable whether it is a recipe or the front page of a newspaper, even if the content is replaced by X's (cf. Figure 16). What counts and works as a graphetic dispositif is, of course, utterly culture-specific, not to mention influenced by an abundance of other factors (period, region, familiarity of a genre etc.).

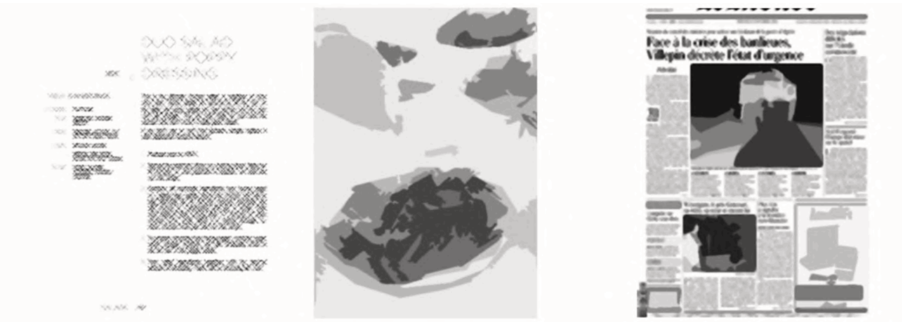

Figure 16: Graphetic dispositifs of a recipe (left/middle) and a newspaper front page (right)

An insightful macrographetic study that proposes a way of visually distinguishing running texts from lists is Reißig (2015). In his study, Reißig aims to show that graphetics and syntax are connected. To accomplish this, he operationalizes a number of concepts originally devised in the field of typography. In what he terms the *cartography of the medial (under)ground*, he vertically divides the page into three equally wide *list spaces*: left – middle – right. If the items of a list are not visually marked by bullet points, it is indeed crucial for the perception of lines vs. running texts how much of the linear space is filled: just the left list space, or does the text run beyond that? To distinguish the *list mode* from the *text mode*, Reißig (2015: 33-35) proposes the feature [±CONTINUOUS]. Lines that occupy not only the left but also the middle and right list spaces are [+CONTINUOUS], lines that occupy only the left or the left and (parts of) the middle space, are [−CONTINUOUS]. These feature values are visually salient, and what is perceived by a reader as a list or as running text is a matter of graphetic dispositifs. In this vein, in another contribution, Reißig & Bernasconi (2015: 235) empirically test the perception of these graphetic dispositifs and arrive at the conclusion that with decreasing length of lines (= occupation of the linear space), readers decide in favor of the list mode. Not only does Reißig's contribution greatly enrich grapholinguistic theory, but it also constitutes important evidence for the claim that writing is a system in its own right, as the list mode proves that in writing, because of its spatial nature, there are modes of organization that have no equivalent in speech.

4. Paragraphetics

Micro-, meso-, and macrographetics treat all those graphetic phenomena that are perceived two-dimensionally. However, as established above, one of the central features of writing that distinguishes it from speech is that it requires a surface and tools (cf. Dürscheid 2016: 31). Both of these components should also be considered and studied in graphetics. Because a product of writing reveals the material it was made of and often also exhibits traces of the tools and methods it was made with, Stöckl (2004: 37-39) proposes an additional level of analysis that includes the third dimension: paratypography, which, for the sake of generality, I re-termed *paragraphetics*. Stöckl chooses the prefix *para-* for this level because these material aspects of writing affect the entire process of producing and perceiving a product of writing.

The physical features of the writing/reading surface greatly influence processes of writing and reading. Possible properties studied here include the initial choice of paper or other materials as well as their color/brightness, transparency/opacity, surface (matt vs. glossy), greyscale value, and haptic phenomena such as their thickness, density, grammage/weight (cf. Spitzmüller 2016: 101f.; Willberg & Forssmann 2010: 71; König 2004: 97f.), but also external factors such as incidence of light when writing or reading, to name only a few. As König (2004: 73f., my translation) puts it, "optimal typographic readability emerges from the best possible interplay of individual typographic factors with simultaneous consideration of the reception situation and the individual reader".[149] If in a given reading situation, the transparency of the paper colludes unfavorably with the light, the reading process might be hindered to some degree. Ziefle (2002: 50-61) extends the study of these factors to reading on computer screens, showing that contrast/lighting, resolution, and flickering are relevant categories, and that generally, reading on paper offers better conditions than reading on screens. While paragraphetic considerations are far from being linguistic, they are of the utmost relevance when it comes to studying reading and writing. In this vein, Ziefle's conclusion that reading on paper is 'more natural' than reading on screens is based solely on paragraphetic features. This foreshadows that paragraphetics will be a relevant part of the study of graphetic naturalness (cf., for example, Section 3.2.2.2).

2.2.2 Graphematics

Like *graphetics* (and *phonology*, *morphology*, etc.), the term *graphematics* can be understood in two ways: it denotes (1) the central module of a writing system and simultaneously a level of description of languages that are written (cf. Neef 2005 and his *Die Graphematik des Deutschen* 'The graphematics [= graphematic module] of German'), but also (2) the linguistic discipline

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[149] „Die optimale typographische Lesbarkeit ergibt sich aus dem bestmöglichen Zusammenspiel einzelner typographischer Faktoren unter Berücksichtigung der Rezeptionssituation und des individuellen Lesers.“

studying this module (cf. Fuhrhop & Peters 2013 and their *Einführung in die Phonologie und Graphematik* 'Introduction to phonology and graphematics'). These readings are closely connected: as this section is devoted to the graphematic module of writing systems, it is automatically an instance of the discipline graphematics (cf. Berg & Evertz 2018: 188).

The graphematic module links scripts with language systems, and it is this relation between the visual units of scripts and the linguistic units of language that makes visual marks *writing* and distinguishes them from notation or drawing. The units resulting from this link with language are units of writing, and, since writing is defined as a modality of language, they, too, are units of language. However, they have a special status that is yet to be determined since they qualify as units of language only by virtue of *representing* units of other levels of language such as phonemes and morphemes.

There exist a lot of differing opinions on the nature of these units of writing and on the question of how they should be defined. The most heated debate is without a doubt the one surrounding the so-called *grapheme*, a term that is often intuitively but vaguely interpreted, in analogy to *phoneme*, to denote the smallest or basic unit of writing. It seems this "problematic" term (cf. Birk 2013) is fraught not only with myriad different attempts at a definition but also with general doubts about how meaningful it is to even assume such a unit. The pertinent questions of how such a basic unit of writing can be conceptualized and if there is indeed a definition for it that holds across writing systems are addressed in Section 2.2.2.1. Equally pressing is the issue of *allography*. Understanding allography depends crucially on a definition of the grapheme. Different types of allography and their expression in typologically different writing systems will be discussed in Section 2.2.2.2.

However, the grapheme as a basic unit of writing is not the end of the story for graphematics, which Bredel (2008: 10, my translation) explains:

> Every writing system is equipped with a limited amount of graphic material that is arranged to form motorically executable, visually sufficiently discriminable graphic units (in alphabetical systems letters, special characters, punctuation marks, etc.) as well as a regular combinatorics of these units (writing direction, alternation between graphic material and empty spaces, etc.) for the composition of linguistic units (such as syllables, words, sentences).[150]

What she means by "composition" is that not unlike other linguistic levels, the graphematic module is structurally complex. Just as phonemes are combined to form syllables, feet, phonological words, etc., and morphemes are combined to form words, graphemes can be combined to form various larger units of writing. Among the units described in the German grapholinguistic literature are the graphematic syllable, the graphematic word, and the graphematic sentence. What is terminologically striking in listing these different units is that all of their designations are derived by simply adding 'graphematic' to the name of a unit that is the subject matter of different linguistic levels: the phonological level (syllable), the morphological or morphosyntactic level (word), and the syntactic level (sentence).[151] Thus, these terms ostentatiously imply that writing is fundamentally dependent on language and analyses of language. This, as was discussed in Section 2.1, is not inaccurate.

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[150] „Jedes Schriftsystem verfügt über eine begrenzte Anzahl graphischen Materials, das zu motorisch ausführbaren, visuell hinreichend diskriminierbaren graphischen Einheiten aufgebaut wird (in Alphabetschriften Buchstaben, Sonderzeichen, Interpunktionszeichen etc.), sowie über eine regelhafte Kombinatorik dieser Einheiten (Schriftrichtung, Alternation zwischen graphischem Material und Leerstellen etc.) zum Aufbau von sprachlichen Einheiten (etwa Silben, Wörter, Sätze)."

[151] Similarly, the grapheme has been called *phono-grapheme* (cf. Heller 1980; for a critical evaluation of this term, cf. Günther 1988: 73) or *phonological-fit grapheme* (cf. Herrick 1994) in the past. These terms stress one function of alphabetic graphemes, their representation of a phoneme or multiple phonemes. There existed a complimentary term for graphemes that were gathered by means of graphematic minimal pairs alone. They were called *grapho-graphemes* or *graphemic graphemes* (cf. Section 2.2.2.1 for a comparison of the phono-grapheme and the grapho-grapheme).

However, ironically, reducing writing to other levels of language (especially the phonological) is exactly what the grapholinguists proposing these units take a stand against: in fact, these concepts stem from the phonology-autonomous approach to graphematics that assumes graphematic units either distributionally and/or based on – mostly material – features of writing alone. Designations such as graphematic syllable, as will be shown below, are thus only intended to highlight *parallels* to polysegmental units of other modalities, e.g. the phonological syllable or the syllable in sign language with whom the graphematic syllable shares abstract organizational features. The term, however, as misleading as it is, is not meant to insinuate that the graphematic syllable is dependent on or represents the phonological or signed syllable.

What, however, could graphematic units be that can be assumed on the basis of the features of writing alone, i.e. "intra-graphematically" or "graphemically", as it would be called in the German grapholinguistic literature? Any attempt to answer this faces great challenges such as the question of which decisive criteria exist that can help recognize graphematic units larger than the grapheme when the reference to or correspondence with linguistic units is discarded. Precisely at this point, the graphetic units described above take center stage, and the strong interrelations between the materiality of writing and its linguistic functions come to the forefront, proving that the materiality aspect is not accidental or secondary, but in fact crucial in any serious study of writing. In this vein, it is not surprising that all of the empty spaces that were identified script-graphetically in Section 2.2.1.2 are – with the notable exception of the line break – linguistically functionalized.

Although, as mentioned, the graphematic syllable, foot, word, sentence, etc. stem from a relatively modern discussion in phonology-autonomous German grapholinguistics, they suffer from Eurocentrism and alphabetocentrism. In the way these units – the graphematic syllable and graphematic word, to some degree also the graphematic sentence – were proposed, they are severely limited in their applicability to non-alphabetic writing systems. This criticism must be countered by acknowledging that most works treating these aforementioned units (for example Fuhrhop 2008; Fuhrhop & Buchmann 2009; Schmidt 2016) state *explicitly* that their scope is restricted to the German and, sometimes, additionally the English writing system(s). However, this is in some ways as grave, since similar to how a language-specific definition of the phoneme or the phonological syllable would be absurd, a language-specific definition of the grapheme or the graphematic syllable is, too. (Or is it?) Why has the untenability of language-specific definitions of basic linguistic units not spilled over to graphematics?

This critical introduction leads to the pressing question whether these graphematic units, i.e. the graphematic syllable, word, sentence, also occur and are of relevance cross-grapholinguistically. Let us start with the basis of it all, the infamous *grapheme*.

2.2.2.1 Grapheme

When considering the immense scrutiny that the term *grapheme* has been subjected to basically since it first came into use, it appears imperative to initially point out why I believe positing such a unit and defining it in a universal manner is a reasonable endeavor. This includes the same reasons for which I regard the use of other more or less established terms such as *letter*, *character* or vague placeholders like *sign (of writing)*, *symbol*, etc. as problematic: it obscures the fact that 'a letter of German' and 'a character of Chinese' might have features in common, features that could very well allow for their unified classification as graphemes of their respective writing systems. Unfortunately, it *does* get a little more complicated than that (cf. Häffner 2009 for a comparison of basic alphabet units and basic units in Japanese). Labeling the smallest functional unit of the German writing system 'a letter of German' might suffice and be terminologically adequate in an isolated description of the German writing system. It might even allow for comparisons with other writing systems of the same type, i.e. alphabets, and their respective 'letters'. Ultimately, however, it dissociates the results from the overall picture and a global grapholinguistic theory. If we ever want to compare diverse writing systems – and why would we not? –, we *do* need the grapheme or something along its lines. But what exactly is it, and equally important, what is it *not*, and why is it such a source of controversy?

From a descriptive and structural point of view, the simple argument in favor of the grapheme is that, as established above, all writing systems are structurally complex. Every writing system sports some kind of minimal unit that is used to compose larger units. 'Unit', here, is already interpreted graphematically: these units of writing must have a linguistic function, be it to differentiate meaning, bear meaning (and thereby automatically differentiate meaning), or to convey some other kind of linguistic information. Irrespective of which exact functions they fulfill, from the perspective of the writing system, these units represent its smallest entities, the basic units of writing. I propose that these entities should be treated as graphemes. The next step that is necessary is to identify these entities and their features in diverse types of writing systems and to analyze their cross-grapholinguistic commonalities as well as their differences.

In the complicated history of grapholinguistics, three different strategies of dealing with the grapheme have emerged. First, there are (1) *opponents* of the grapheme, the most prominent of which is Peter T. Daniels, who is simultaneously also the best-known scholar of writing systems. In one of his more recent encyclopedia entries on writing systems, under the heading 'Writing and Language', Daniels lists various reasons that lead him to believe that the grapheme "has become nothing more than a pre-theoretic, fancy, scientific-sounding word for 'letter' or 'character' and ought not to be part of technical discourse" (Daniels 2017: 88). I want to discuss these points one by one to show that opposing and thereby dismissing the grapheme is, for the sake of a broader grapholinguistics and a comparison of writing systems that transcends mere individual descriptions, not the way to go.

Daniels's main point traces back to his rejection of a 'structural graphemics' (Daniels 1991) in which he argued writing and language must be treated differently because language is unconscious while writing is conscious.[152] His reasoning is not primarily linguistic – as he claims, "writing is not like language, and it is not like language for biological reasons" (Daniels 2017: 88). One observation that he uses to underline this statement is that children do not acquire literacy without instruction and that there appears to be no critical period for it since illiterate adults can still learn to write and read without difficulty. Additionally, he notes – much like Dehaene (2009) formulated famously – that there is no "special capacity" (Daniels 2017: 88) for writing because it is too recent an invention for humans to have evolutionally adapted to it.

Daniels states that phonemes and morphemes are unconscious properties of language "and other realms of human behavior" (Daniels 2017: 88), which accounts for the suffix *-eme* that is used to designate abstractions. Writing, however, is "not an unconscious, built-in feature of a mind" and therefore "cannot a priori be assumed to be analyzeable in a parallel way" (Daniels 2017: 88). This seems to be Daniels's only – but nonetheless major – contention against *graphem(at)ics* as a subbranch of linguistics that treats and studies writing systems as linguistic systems, including the units that have been assumed in analogy with other linguistic units such as the phoneme or the morpheme. The specific reservations he expresses against the grapheme – in a nutshell, its seeming multifunctionality *within* individual systems and the different functions it supposedly fulfills *across* systems – will be discussed below, but first, I want to comment on the claim that writing cannot be studied analogously to language. There really is no clear-cut distinction between 'writing and language', as writing – if defined glottographically, as it is done by most scholars nowadays – is always a form, specifically a modality of a language system. Therefore, it is logically not positioned at the same level as phonology or morphology, subsystems that are necessarily *inherent* to each language system. Phonology is not optional in a language system. However, graphematics is. Yet, graphematics behaves much like

[152] In this respect, Kohrt (1986: 93) agrees with Daniels, stating: "Writing always presumes some kind of consciousness (which is not necessary in the sphere of spoken language) […]". Note, however, that Kohrt speaks of spoken language while Daniels speaks of language in general.

these other systems in various regards: as established above, what is central for the proposal of a grapheme definition is the structurally complex nature of graphematics.

Most statements Daniels makes about writing are correct. It is not acquired without instruction and it is, in fact, both phylogenetically and ontogenetically secondary to speech (cf. Dürscheid 2016: 30). There is no brain region that has evolved specifically for reading or writing, as other areas with similar functions have been neuronally recycled in order to now take on the tasks of reading and writing (cf. Dehaene 2009: 144-147). And finally, writing is more conscious than language as writers and readers need to be – at least in the process of acquiring a writing system – consciously aware of the units of writing they employ. But it is much more than that: readers and writers are not only conscious of the units of writing, but by virtue of using them, they must also be aware of the linguistic units (or properties, as per Daniels) that the units of writing refer to. Writing not only requires phonological or morphological awareness, but more generally metalinguistic awareness. Writing is not only conscious itself – it also makes language conscious.

This means that writing, as an optional modality of language, always constitutes an analysis of language. As Reiner (2000: 1) puts it: "The invention of writing may well be considered testimony of linguistic analysis of the spoken language", with the exception that it is not only spoken language (here in the sense of "phonology") that is analyzed but other linguistic levels as well. Interestingly, even Daniels (2013: 53) himself has stated something similar, namely that "[e]very writing system represents a 'native-speaker analysis' of a language, and as such at every stage of its development it reflects what its users consciously 'know' about their language" (cf. also Dürscheid 2016: 39).

The question is, should the fact that writing operates on another level, making the 'unconscious' properties of language conscious, preclude us from analyzing it with the same or similar tools and concepts that are used to analyze other – phonological, morphological, etc. – levels? Rogers (2005: 11) clearly negates this, claiming "the fact that the data of language and writing are different in nature does not preclude our using a similar theoretical framework" (cf. also Primus 2004: 237). The most crucial reservation about Daniels' rejection of graphematics, one that cannot easily be resolved, is: is writing really always so conscious? Once acquired successfully, are the processes of reading and writing not often dominated by automatisms? If someone is a fluent and competent writer in his native (or even a second) writing system, is there really a conscious process involved in writing down an item on a shopping list? If I want to write down 'milk', do I always map each phoneme that I intend to write to a grapheme and, in a next step, to a basic shape that I am about to graphomotorically substantiate? Conversely, is pronouncing something in speech always unconscious? And with respect to performance, a question that challenges the claim that writing is always conscious is how and why unconscious mistakes happen in writing.

With respect to the distinction between an etic and an emic level, going back to Kenneth L. Pike ([1954] 1967: Chapter 2), there undoubtedly exists an emic level in writing, as concrete substantiations can be – or even must be – classified into abstract categories to make an analysis even possible. An emic unit is defined as "an invariant form obtained from the reduction of a class of variant forms to a limited number of abstract units" (Nöth 1990: 183). As we will see, graphemes are the smallest emic units of graphematics, as they relate a graphetic form, a basic shape, itself an emic unit, to a linguistic unit.

Daniels mentions two more arguments against the grapheme that go hand in hand. First, he argues that what has been called *grapheme* in different works has varying functions, depending on the unit that it was analogously modeled after: like the phoneme in a phoneme inventory, it sometimes is seen as a unit of a set of units that comprise a writing system; like the tagmeme, defined as "the correlation of a grammatical function or slot with a class of mutually substitutable items occurring in that slot" (Elson & Pickett 1962: 57), it is the correlation between a syntagmatic function and a paradigmatic filler; like the morpheme, it is "a minimal extent of something" (Daniels 2017: 88).[153] While he agrees on the fact that each of these definitions might be suitable for given (types of) writing systems, Daniels notes that they cannot be satisfactorily reconciled in a coherent definition of the grapheme that applies to all writing systems – something that, however, is demanded from a universal grapheme definition.

In a different contribution, Daniels, together with his collaborator David Share, claims that "'[g]rapheme' has had so many different interpretations that in writing systems theory it is meaningless" (Share & Daniels 2016: 23). While the first part of this statement is undeniably true, as will become evident below, it can in itself not be counted as a sufficient reason to altogether dismiss the idea behind the term and the term itself and to discard it as "meaningless". As Rogers (2005: 11) posited with respect to the grapheme (and other grapholinguistic terminology), "we can define and use our terms carefully". One of the many definitions for the grapheme that have been proposed might be the right one, or the right one has yet to be formulated. The truth, I believe, lies somewhere in the middle: some of what has been proposed under the heading of *grapheme* will turn out to be accurate while other aspects can indeed be dismissed. The ultimate truth that is at the core of Daniels's problem with the grapheme is that the shocking majority of efforts in defining it has taken place in isolation from the larger linguistic picture. While the history of the phoneme and the morpheme is one that necessarily ventured for universality pretty quickly, for the grapheme, it was always 'a grapheme of German' or 'a grapheme of Chinese', but never a 'general grapheme' that can truly explain how all writing functions at its core. This, of course, is an understandable reaction to the typological diversity of writing systems (cf. Section 2.3) which, at first glance, might discourage grapholinguists from seeking out the possibly universal nature of the grapheme.

Another aspect Daniels (2017: 88) briefly discusses is that "many alphabets use a pairing of symbols – capitals and lowercase, majuscule and minuscule – that has no equivalent in sound systems". Another example he gives in this context is italics (cf. Daniels 2018: 169). While it is true that neither capitalization nor italics have direct equivalents in speech, this is neither an argument against analyzing the graphematics of a writing system in a structuralist way nor against the possibility of defining a grapheme. While writing does represent language in a written form, it *also* has 'a life of its own'. Capitalization undeniably has a function in the systems in that it exists. Thus, not everything in writing must refer to something in "sound systems", and equally, not everything in writing must have an "equivalent in sound systems". As elaborated in Section 2.1, writing is a system in its own right, not least because of its visual materialization that follows altogether different regularities and laws than the acoustic materialization of speech. So yes, while the uppercase and lowercase 'letters' in an alphabet do not refer to different phonemes, meaning they refer to no difference at the phonological level, and there exists no functional equivalent to this case distinction in phonology, i.e. "lowercase and uppercase phonemes", this contrast in writing might have a different function at a different level (see below), take the morphological (e.g., differentiating parts of speech in German) or the syntactic level (e.g., marking the head of a noun phrase), or even the graphematic itself (e.g., marking the beginning of a graphematic sentence). Treating writing with linguistic methods does not mean that a) everything in writing has to be derived from phonology (or "sound systems"), which is what the *phonology-dependent hypothesis* holds, or that b) everything in writing must have an analogous equivalent in phonology or some other linguistic level (*phonology-autonomous hypothesis*). There is some truth in both, but neither of them gets it right on their own and even in combination, they do not capture the complexity of the whole picture.

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153 Mugdan (1990: 50, emphasis in original) comments on the general vagueness of linguistic terms ending in *-eme*: "The insatiable need for designations of linguistic units ensured the remarkable success of the new derivational pattern, but the combinations of *-eme* with suitable roots (*morph-*, *graph-* and the like) have such general meanings ('unit of form', 'unit of writing' etc.) that one could utilize them to name any of several different concepts".

Of these arguments against the grapheme, I want to return to the one about 'too many incoherent definitions', as it leads to a second strategy of dealing with the grapheme. Many people are what I call (2a) *non-committers*. They use the term *grapheme* freely and most often without definition,[154] ultimately leaving it up to the reader to decipher its meaning and wonder what is intended by the use of the term. In doing that, they avoid committing to a specific definition of the term. This empty and in a way careless use is indeed so frequent that Daniels's aversion to the grapheme becomes, to a large degree, relatable. However, this type of use is predominantly found in non-linguistic works, e.g. in psychology, the cognitive sciences, pedagogy, etc. Alas, because of the interdisciplinarity of the field, works about writing that are of relevance to grapholinguistics are affected by this misuse. Moreover, it is not only publications on alphabetic writing systems that tend to (mis)use *grapheme*, but also works on non-alphabetic writing systems.

Take, for example, a study about handwritten character production in Chinese (Chen & Cherng 2013). In the first paragraph of the paper, they say "[t]he letters or graphemes serve as functional units in the orthography of a word" (Chen & Cherng 2013: 1). Here, evidently, *grapheme* is used as a synonym for *letter*, justifying Daniels's statement that the term often serves as a more scientific-sounding alternative that can be abandoned without loss.[155] In a study about reading in Thai, Winskel and Iemwanthong (2010: 1024, 1028) write of, for example, "consistent grapheme to phoneme mapping" or "children's phonological knowledge and ability to map sublexical units onto graphemes". However, they fail to define what a grapheme is or what units comprise the grapheme inventory of Thai. *Grapheme* is obviously meant to be some sort of functional written unit, but in a typologically phonographic but non-alphabetic writing system such as Thai, is it so intuitively obvious what the graphemes are? Is it just the consonant 'signs' or also the secondary and dependent vowel 'signs' (often called diacritics[156])? Winskel & Iemwanthong (2010) also frequently use the term as a part of the common phrase "phoneme-grapheme-correspondences" or, depending on the analysis' perspective, "grapheme-phoneme-correspondences". These technical expressions also have their roots in works on alphabetic writing systems and are not without flaws, especially if used without a prior definition of the individual components. Taha, in his study on reading and spelling in Arabic, also addresses these correspondences. When he first mentions basic shapes (only scriptual basic shapes, i.e. no digits, special characters or punctuation marks), he uses the term *letter*: "Arabic is a language written in an alphabetic system of 29 letters […]. Arabic letters have more than one written form, depending on the letter's place in a word: beginning, middle, or end" (Taha 2013: 725). Here, *letter* seems to be an abstract notion whose materialization are *written forms* that depend on the position of the letter. In a later passage, Taha changes his terminology, writing "the basic and non-connected shape of the grapheme س could change according to its placement within the word" (Taha 2013: 725) – letters are now *graphemes*, written forms are now *shapes*.

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[154] At this point, I have to recount an anecdote from a workshop on writing systems I attended in Nagoya, Japan, in 2017. There, I presented the heart of this present chapter on the definition and the use of the term *grapheme*. I was the third speaker on the first day of the conference, so most of the other talks of the workshop came after mine. What my talk ignited was rather entertaining: some speakers after me used the term *grapheme* in their talks, only to become instantly aware of what they had done and back away from the term right after. The laughter of the crowd as well as the presenters themselves to comments such as "I am afraid to use the term *grapheme* now" or "I suppose I am using *grapheme* wrong" proved that very frequently, there is no reflection on what *grapheme* really stands for and that the term is used in various meanings. That this happens even *within* the grapholinguistic community should serve as a wake-up call to either really abandon the term or finally organize the definitional mess around it.

[155] Additionally, they describe units called *logographemes*, "the smallest units in a character that are spatially separated, and they appear in many characters" (Chen & Cherng 2013: 2).

[156] Note the problematic use of the term 'diacritic' in this context. For a discussion on this topic, see Daniels (2006a), Kurzon (2008), and Daniels (2009b).

Also part of this non-committing category are, shockingly, some very prominent and relevant textbooks and introductions in the field of grapholinguistics, in which the grapheme is attended to very briefly and unspecifically (Sampson 2015) or not mentioned at all (Coulmas 2003).

Uses such as the above are numerous. They contribute to the overall impression that *grapheme* indeed has no fixed meaning as a term and concept. This causes some scholars, the (2b) *neutrals*, not to dismiss the concept altogether, but to avoid it in favor of other, supposedly more specific terms.[157] One of them is Martin Neef, who also laments over the fact that the grapheme has been used with a variety of heterogeneous meanings (cf. Neef 2005: 36). In his seminal work on the graphematics of German (Neef 2005), he opts out of using *grapheme* and uses *letter* (German *Buchstabe*) instead. However, unlike Chen and Cherng, he does not treat the terms as synonyms, and unlike Daniels, he does not argue that there is no or that there cannot be a unit called *grapheme*. However, he argues that the concept of letter is sufficient for the description of the German writing system, and that, while it might be a useful concept elsewhere, the grapheme is superfluous. Especially in the present context of a comparison of writing systems that differ typologically, I want to critically evaluate the choice of *letter* as the smallest functional unit – even if it was proposed within an exclusive analysis of the German writing system.

Neef (2005: 37) uses the graphematic word <Schnee> 'snow' to illustrate that the grapheme, if such a unit is assumed, is a notion different from the letter. Since he – following both the referential and the analogical views (with exceptions, see below) – analyzes <sch> as one grapheme, <Schnee> consists of the four graphemes <sch>, <n>, and two instances of <e>, and simultaneously of six letters, because <sch> is itself a complex grapheme made up of the three letters <s>, <c>, and <h>. Since <s> as well as <h> and possibly <ch> are commonly analyzed as graphemes as well, Neef notes that in any theoretical framework that includes graphemes, the grapheme must be defined in a way that accounts for the possibility of it being comprised of one letter *or* a combination of more than one letters. A theory of graphematics, he concludes, can function with the unit letter alone or with the units letter *and* grapheme. Due to complex graphemes such as <sch>, it can never function with the grapheme alone.[158] It is, then, for reasons of economy that Neef decides the letter is sufficient for his graphematic theory of German. This does not solve the question of how complex units such as <sch> are to be treated. Since his basic unit is the letter, Neef chooses to call these units *fixed letter combinations* (German *feste Buchstabenverbindungen*, cf. Neef 2005: 41). Interestingly, because letter already functions as the designation for the smallest linguistically functional and abstract unit, Neef is also in need of a new term to designate the (also abstract) graphetic manifestation of these abstract units, what I have called *basic shape*. Here, he chooses *letter body* or *letter gestalt* (translated from German *Buchstabenkörper*, cf. Neef 2005: 39).

Conceptually, I agree with Neef on all accounts. It is merely a terminological shift that I propose in the approach laid out here. The reason for my insistence to keep the *grapheme* is that it allows comparisons between different writing systems. While *letter* or *character* might suffice in individual descriptions, a definition of *grapheme* that captures the minimal linguistically functional unit of *any* given writing system reflects that at the core, they all share a crucial function: visually representing language (and not just speech). As mentioned above, Neef's

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[157] Berg's study serves as a fitting example for this strategy of acknowledging graphemes, but not exactly dealing with them: "This paper will primarily deal with letters, not with graphemes. The distributional analysis is facilitated if we deal with letters first. This is not to say that graphemes can or should not be part of either method, but at this stage of investigation it seems legitimate to exclude graphemes" (Berg 2012: 39).

[158] „Unabhängig von der Frage einer intensionalen Definition des Begriffs Graphem liegt nach meinem Verständnis in einer Theorie nur dann die Grundeinheit Graphem vor, wenn Grapheme sowohl aus einem als auch aus mehreren Buchstaben bestehen können. Auf der Basis dieser Überlegungen kann eine Theorie der Graphematik entweder nur mit Buchstaben oder mit Buchstaben und Graphemen arbeiten, nicht aber mit Graphemen allein" (Neef 2005: 38).

introduction of *letter body* shows that his functional interpretation of *letter* leaves a vacancy regarding the graphetic units that take part in graphematic relations. I argued that *letter* is a graphetic term, much like *character* (cf. Section 2.2.1.2). Both terms signify types of basic shapes and therefore could simply be replaced by the umbrella term *basic shape*. The additional information they give is what kind of script they are part of, although that is only partially true for *letter*, since it enjoys great popularity whenever talk is of the units[159] of an alphabet – not only of alphabets using Roman script, but also the Georgian, Armenian, Cyrillic, Greek scripts. Furthermore, the term has spread to the basic shapes of scripts that are used for typologically different writing systems: take the Arabic script, whose units are also commonly referred to as *letters* (cf. Saiegh-Haddad & Henkin-Roitfarb 2014: 15). In fact, this overgeneralization of the term reveals aspirations of finding a common ground across different writing systems by using the same designation for their units. It is this very motivation that also motivates the definition of a grapheme.

If *letter* is already occupied as the script-specific term for *basic shape*, a graphetic unit, there is, again, a need for a label for a basic graphematic unit that applies cross-grapholinguistically. If we call this unit *grapheme*, then combinations of graphemes are called *complex graphemes*. To sum up, I replace Neef's terms *letter body, letter,* and *fixed letter combination* with *basic shape, grapheme,* and *complex grapheme*, respectively.

Another model that does not dispense with the grapheme altogether but that dramatically reduces its relevance in graphematics in comparison with older approaches is the suprasegmental model of writing developed by Beatrice Primus and her colleagues (cf. Figure 17). This model evolved from the idea that the syllable can be described not only as a salient unit of spoken language but of sign language and written language as well. As such, it is interpreted as a medium- (or modality)-independent unit (cf. Primus 2003, cf. Section 2.2.2.3). As in Neef's model, the *letter* is an abstract linguistic unit that fulfills the most crucial function (cf. Berg 2018: Chapter 3.1). Whereas for Neef, letters are abstract functional units, and their concrete physical manifestations, the letter bodies, are analyzed holistically (and are interpreted as arbitrary[160]), Primus proposes a level below the letter. Thus, letters of the Roman 'alphabet' derive their referential value and, consequently, their function compositionally as their segments' visual features correlate with phonological features (cf. Primus 2004, 2006). This suggests that graphetics and graphematics are more tightly interlocked than is traditionally assumed as letters are not interpreted merely as arbitrary holistic shapes but as simultaneously visual and functional units with a complex internal structure.

A second aspect that distinguishes the suprasegmental model from Neef's model is that an additional level of skeletal positions is assumed above the level of letters. The authors suggest that these skeletal positions could possibly be graphemes.[161] In the majority of cases, one letter will be associated with one skeletal position, i.e. single letters often simultaneously function as graphemes. By giving the term and the concept *letter* priority, Primus and her colleagues imply – in a manner similar to Neef's – that in many cases, as they coincide with graphemes, letters actually do suffice, and that the grapheme concept is only interesting for

[159] I speak here of units and not of basic shapes because much like grapheme, *letter* has often been used vaguely and it is not always clear whether what is meant by it is the visual form, its linguistic (= representational) function, or both.

[160] However, Neef (2005: 39) does not rule out the possibility that letter bodies can be structured complexly. In his approach, however, this hypothetical complexity does not play a role.

[161] Schmidt (2018: 128) points out a problem of treating the skeletal positions as graphemes: in graphematic words such as <beten> or <lesen>, the first vowel, in each case an instance of <e>, would be associated with two skeletal positions, respectively, since these graphematic words are simultaneously, as graphematic feet, trochees, i.e. their first graphematic syllables are 'strong' or 'prominent'. As Schmidt argues, it would be absurd to claim that the first <e> in this word represents two graphemes. Skeletal positions, thus, do not straightforwardly correspond with graphemes. Schmidt also notes that Primus and colleagues silently acknowledge this by having changed the designation of the skeletal positions from "G" (for grapheme) to the more neutral "X" in newer versions of the model.

letter combinations that behave like single letters, for example <sch> in German (cf. Schmidt 2018: 138). However, letters can also be combined, and more than one letter can be associated with a single skeletal position, which is how in this model, too, <sch> is regarded as one grapheme consisting of three letters (cf. Berg, Primus & Wagner 2016: 351). Unlike Neef's model, in which these sequences are called fixed letter combinations, the suprasegmental model needs (or better chooses) *grapheme* as a designation for these complex units. To sum up, as I argued elsewhere, the reliance on the letter as the most central unit in these otherwise promising approaches is problematic, as it obscures the fact that non-alphabetic systems might share features with alphabetic systems (cf. Meletis 2017: 112).[162]

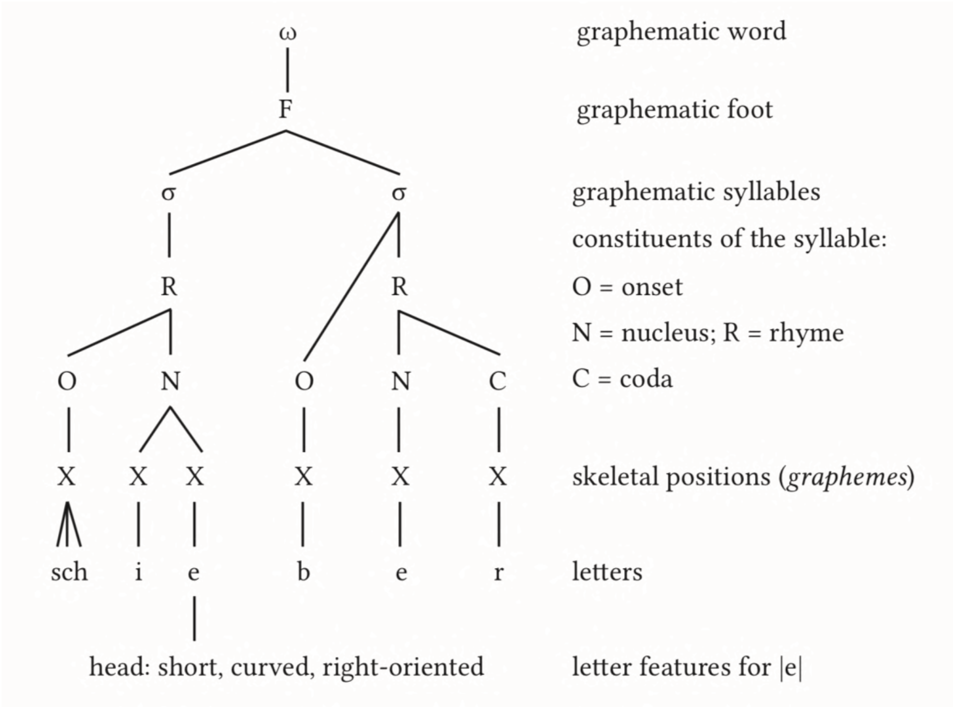

Figure 17: Suprasegmental model of writing, from: Berg, Primus & Wagner (2016: 351)

What remains is the third strategy of dealing with the grapheme, the most important one for this thesis: the assumption and acceptance of graphemes as relevant functional units of writing systems. In the models and theories of the grapheme's (3) *proponents*, it plays a crucial role. However, even among them, there is no consensus about what exactly the grapheme is, how it is identified and what functions it fulfills in a writing system and in a language system as a whole. The two most influential conceptions of the grapheme are the (3a) *referential view* and the (3b) *analogical view* (cf. Kohrt 1986; Lockwood 2001). They are closely linked to the differing views of the relation between writing and language – or more narrowly, writing and speech. In Section 2.1, I termed those the i) phonology-dependent hypothesis and the ii) phonology-independent hypothesis, respectively. While scholars adhering to the first of those views interpret writing as a representation of speech (or phonology), proponents of the latter view see writing as a form or *modality* of language autonomous from speech (or phonology).

What do these different hypotheses mean for the definition of the grapheme? In the referential (or *representationalistic*, cf. Coulmas 1996a: 175) view, graphemes are signs of phonemes, while in the analogical (or *distributionalistic*, Coulmas 1996a: 175) view, graphemes are

[162] Focusing on the letter might be understandable and acceptable in the context of descriptions of alphabetic systems, but not in the context of an attempt to establish a model of writing systems in general. Thus, choosing the letter as the unit of written language in the title of a handbook (Domahs & Primus 2016) – as in *Laut, Gebärde, Buchstabe* (transl. *Sound, gesture, letter*) – is questionable, especially since the selected units for spoken and sign language are applicable universally.

identified analogously to phonemes and are, thus, defined as the smallest functional units of writing, regardless of whether they correspond with or represent phonemes (or other units of language). Like Kohrt (1986), I argue that in isolation, both views prove insufficient for explaining what the grapheme is – at least cross-linguistically. However, I also agree with Lockwood (2001: 307) in that "students of writing need to include both kinds of relations in any model they adopt". Accordingly, there is some truth in both of them, but neither of them gets it completely right. The obvious Eurocentrism that plagues these conceptions will be addressed after elaborating on the challenges they face even when applied exclusively to alphabetic systems, in other words: the very systems they were designed for.

Proponents of the referential view treat graphemes as units that stand for phonemes in written language, functioning as "phoneme signs" (Kohrt 1986: 84). This view is confronted with several problems. As Günther (1988: 76) points out, if graphemes are derived from phonemes, there is no need for the concept of grapheme to begin with, as they would simply be written labels for phonemes. In this sense, graphemes would not be units, but relations, correspondences, or rules.[163] Another issue that Günther addresses is allography. In the referential view, allographs are those units that are used to write one phoneme, which leads to the theoretically and terminologically absurd situation of assigning allographs to a phoneme instead of to a grapheme (cf. Günther 1988: 76). Thus, the allographs that Garbe (1985: 12f.), who is harshly criticized by Günther, lists for the phoneme /f/ are <f ff v w + fe ph>, with <fiel/Suff/viel/ Möwchen + Safe/Philister> given as examples in which these allographs occur and represent /f/ (cf. also Zifonun et al. 1997: 273-280 for an exhaustive list of German sound-grapheme correspondences).

This unveils two additional aspects of the referential view that are problematic: Firstly, the direction of analysis is phoneme to grapheme. Primacy is given to encoding phonology in graphic form and, thus, to production processes. This is not a problem *per se*, but a choice – a choice that, through highlighting phonology, yet again, gives primacy to speech and strongly insinuates writing is merely a derivation of speech. Modern approaches such as Neef's (2005) either choose the opposite direction for their analysis or decide to 'use' both, postulating bidirectional mapping relations (cf. Evertz 2016: 381).[164] Secondly, Kohrt's (1986: 87f.) major criticism of the referential view echoes Günther's sentiment that in this conception, graphemes are not units, but relations: phonemes are subject to context-sensitive variation. Accordingly, if there were a one-to-one equivalence between phonemes and graphemes, which is what "has always been considered as something that should be aimed at" (Kohrt 1986: 87), writing systems would be transcriptions. But they are not. As Kohrt (1986: 88) notes,

> what you will get [...] is a phonemic transcription [...] – but you will never arrive at something like a traditional orthography. [...] As far as orthographic writing is concerned, the structure-determined phonemes cannot serve as the relevant correspondence units; it would be a mistake to look at the written marks that are important for the orthography as 'graphemes' which are defined by their relation to the phonemic entities.

A variant like <ff> is, thus, not, as Garbe proposes, an allograph of a phoneme /f/ or even of a grapheme <f>. As graphemes are to be defined as *minimal* functional units of writing, it is a sequence of two functional units, two graphemes <f>. The doubling of the consonant grapheme is determined by graphematically higher levels (cf. Birk 2013; Schmidt 2018: 32f.), in this case the syllabic level: in <Staffel> 'relay', for example, the doubling of <f>, in a dependent view, signifies the phonological quantity of the preceding vowel and that the /f/ that it represents is

[163] „Der Begriff Graphem in der Lesart der Repräsentanzkonzeption ist kein Analogon zum Begriff Phonem, das solchermaßen definierte Graphem ist systematisch nicht als Einheit klassifizierbar. Es ist eine Relation, die Beschreibung eines Umsetzungsprozesses, eine Regel oder was immer, jedenfalls keine Einheit, kein Segment" (Günther 1988: 76).

[164] Note that Neef (2005) chooses the direction letter-to-sound, but he regards both directions as relevant: "In the end, it is evident that a theory of writing systems has to model regularities in both directions" (Neef 2015: 713).

ambisyllabic (cf. Primus 2010: 20-25). In an autonomous, non-linear view (see Primus's model above), the doubling is determined by the structure of the graphematic foot and signifies that the <a> is associated with only one (instead of two) skeletal positions. Thus, it is the structure of graphematic feet and syllables in German that conditions the variant <ff>. In both views, it is not an idiosyncratic spelling, but an explainable one (cf. Schmidt 2018: 33; cf. Fuhrhop & Peters 2013: 229-238). In any case, there is no need to assume <ff> as an independent unit let alone as an allograph of <f>, underlining the grave conceptual problems that the referential view encounters. However, for <v> and <ph> as written variants of /f/, the picture is not so straightforward. Their status will be discussed in the context of allography (cf. Section 2.2.2.2).

The second influential conception of the grapheme in German grapholinguistics is the analogical view. Adherents of this view treat the grapheme as the smallest distinctive unit of writing (cf. Fuhrhop & Peters 2013: 202; Günther 1988: 77; cf. Rogers 2005: 10 for an Anglo-American instance of this view). In this view, the phoneme does not serve as the unit the grapheme represents, but instead as a methodological model of how to discover contrastive units of writing. As such, the analogical view is not structurally, but methodologically dependent on phonology (cf. Berg 2018: 17). In structuralism, the phonemes in a language's phoneme inventory are identified with the help of the substitution of segments, which yields minimal pairs. The same, analogists argue, should be done with written language. Minimal pairs such as German <danken> 'to thank' and <tanken> 'to refuel' reveal that the contrasting units, if they render a difference in meaning and create two existing and meaningful words of a language, are graphemes – in this case <d> and <t>. Thus, graphemes are parallel to phonemes (and morphemes in morphographic systems, cf. Rogers 2005: 10). This approach, Eisenberg (2006: 302) argues, is first and foremost a methodological postulate. This method of "discovering" the grapheme inventory of a writing system is largely uncontroversial as long as the writing system in question is – again – segmental, i.e. ironically a writing system in which a written unit corresponds with a phonological segment. But even in these cases, like the referential view, the analogical view comes with problems of its own.

Kohrt (1986: 88f.) seriously questions "whether it constitutes a reasonable project to transfer discovery procedures that have been designed for a specific substantial domain to a totally different one, imputing that in both areas the problems are just the same".[165] Units of speech and units of writing differ in crucial aspects, of which Kohrt (1986: 89) highlights *segmentation* and *individuation*. The former proves a much easier task for writing than for speech, as it is one of writing's constitutive features that it is made up of discrete segmental units.[166] This, however, does not mean that all the segments that can be identified as segments are automatically to be treated as graphemes, as per definition, only lexically distinctive units are considered graphemes (but see Lindqvist's view below). Thus, it is the aspect of individuation that reveals what graphemes and allographs are – it will be discussed in the next section.

While the method of discovering graphemes through assembling written minimal pairs takes into account that writing is a system in its own regard, it is logically divorced from any phonemes the graphemes might, to use referential terminology, represent, or, to phrase it more neutrally, correspond with. The very method itself, which does not require any prior knowledge about the phoneme inventory of a language, obscures the fact that while graphemes can independently distinguish meanings, this function might be constituted by phonology (cf. Weder 2016: 13). Is the fact that graphemes that are discovered with this method mostly correspond with phonemes not revealing? How much sense does it make to assume that the graph-

165 Günther (1988: 78, my translation) wonders if it might not be the other way around: "Not the presence of segments is a problem for graphematics, but the lack of segments is a problem for the evaluation of a phonology!" („Nicht das Vorliegen von Segmenten ist ein Problem für eine Graphematik, sondern das Fehlen von Segmenten ein Problem für die Bewertung einer Phonologie!").

166 As noted in the section on graphetics and again below, this often does not hold for handwriting, where the basic shapes are connected to each other, as well as in some scripts such as Arabic, where the basic shapes are mostly connected.

eme differentiates meaning independently of linguistic units such as the phoneme and the morpheme? These latter questions are at the core of my own definition of the grapheme.

Even within the analogical view, compiled grapheme inventories often differ slightly. For German, some units such as <sch> are still under discussion, since there exist minimal pairs that treat it as one unit as in <Schaum> 'foam' and <Baum> 'tree', but also minimal pairs in which only one component, either <s> or <ch>, is substituted, cf. <Masche> 'bow' and <manche> 'some', <Masche> and <Maske> 'mask' (cf. Fuhrhop & Peters 2013: 205). In my conception (see below) as well as some autonomous works, <s> and <ch> are clearly treated as two graphemes.

The analogical view does not negate the referential view, but it represents an analysis on a hierarchically deeper level. It is a logical precursor to the referential view. Evidence for this comes from the assumption of grapheme-phoneme-correspondences in the analogical view. Graphemes are gathered analogously to phonemes, but then and only *then* are the relations between graphemes and phonemes explored. The correspondences that result from this enterprise are precisely what the referential view considers to be the minimal units, the graphemes. This accords with Günther's (1988: 76) claim that the referential grapheme is not a unit, but a relation, a phoneme-grapheme-correspondence. Interestingly, in Rezec's (2009) model, both the analogous and the referential graphemes are units: on a lower level, he assumes a grapheme in line with the analogous view – e.g. the graphemes <n> and <g> – while on a higher level, he postulates the so-called *phoneme image* (German *Phonemabbild*) as a separate unit which is a grapheme or a combination of graphemes that correspond(s) with a phoneme, e.g. <ng> which, in German, represents /ŋ/. Rezec's model differs from the traditional analogical view precisely in that the grapheme-phoneme-correspondence is treated as a separate *unit* within the model – thereby disagreeing with Günther and implying that relations can indeed be units, too. The analogical grapheme has also been called *grapho-grapheme* (Heller 1980) or *graphemic grapheme* (Herrick 1994), while the referential grapheme, for Rezec the phoneme image, has accordingly been termed the *phono-grapheme* (Heller 1980) or *phonological-fit grapheme* (Herrick 1994). This highlights that there have been a number of approaches in the past that have attempted to account for both conceptions within one model.

At this point, as anticipated above, I want to highlight how the analogical view is problematic by taking into account Japanese and Chinese, mixed syllabic/morphographic and morphographic writing systems, respectively. In these systems, discovery procedures like the one illustrated above with <danken> and <tanken> are not possible in the same way they are in alphabetic systems. What is sometimes identified as an inherent (and mostly implicit) problem of the analogy conception – that the grapheme must be discovered analogously to the *phoneme* (cf. Glück 2016b: 253)[167] – is not necessarily a problem if the scope can reasonably be widened to allow discovery procedures analogous to other linguistic units.[168] Before testing this possibility, however, I want to reflect *why* this extension of the methodological scope even becomes necessary: if, for Japanese and Chinese, we allow the syllable and the morpheme as relevant units for the analogous discovery procedure (which, as footnote 168 admits, poses problems in itself), how is this extension motivated? Without jumping to conclusions, it appears that the scope is extended to include exactly those linguistic units that the basic shapes of Japanese and Chinese *represent*, which would underscore writing's dependence on language. Thus, ironically, for a treatment of these systems following the "analogical view", the seemingly autonomous

[167] In fact, in these conceptions, authors claim that is indeed only alphabets (and presumably other segmental writing systems such as abjads and abugidas, cf. Section 2.3.2) in which there exists a unit *grapheme*, precisely because only in them does the analogous discovery procedure work. This view that the grapheme is specific to only one type (or a group of types, the segmentally phonographic types) of writing systems is problematic for a number of reasons.

[168] However, one must admit that other linguistic units such as the syllable or the morpheme are, in fact, not exactly "discovered" through minimal pairs, as they are not minimal units themselves.

methodology appears to be influenced by the representation of phonology and morphology, after all.

Having widened the scope, the question is how, if the main criterion is still "marking a lexical contrast", graphemes can be identified in Japanese and Chinese. For Japanese, consider only the syllabic part of the writing system, as morphography is discussed in the context of Chinese: it is not difficult to find minimal pairs in which one "grapheme" is substituted by another. Take <あし> *ashi* 'feet' and <あめ> *ame* 'candy', for example. Given this example, <し> /shi/ and <め> /me/ are graphemes because they differentiate the meaning of the graphematic words. Just like <d> and <t> above, they are graphematically contrastive but do not bear meaning themselves. Just as in the analogous discovery of <d> and <t>, phonographic correspondences, in this case grapheme-syllable-correspondences, of these graphemes are not of concern at this stage. If they were, then the obvious difference to the segmental example above would be that written segments correspond with non-segmental phonological units: syllables.

Typologically, the larger informational size of Japanese graphemes does not seem to pose a problem. Phonologically, in Japanese, there exist no complex consonant clusters that cannot be written with graphemes corresponding with CV-syllables, which would call for a segmental writing system. Thus, with its syllabic writing system, everything that is spoken in Japanese can be written. However, the phonemes themselves, vowels and consonants, that make up phonological syllables *cannot* be written. This leads to a 'drawback' in precision: needless to say, in Japanese, as in any language, there exist phonemes, i.e. there is a phonological level smaller than the syllable. This means that there are classical phonological minimal pairs. It is these minimal phonological contrasts that cannot be written. Writing is, to some degree, underspecified. This is not a problem *per se*. However, it means that what is a minimal pair graphematically does not correspond with what is a minimal pair phonologically: in the above-mentioned case of <あし> vs. <あめ>, for example, the difference is <し> /shi/ vs. <め> /me/. In these syllables, both consonant and vowel phonemes differ. What is a graphematic minimal pair is clearly not a phonological minimal pair. Is there any difference in status between phonologically segmental minimal pairs and graphematically segmental minimal pairs that do not correspond with each other? Since what is evaluated in minimal pairs is lexical contrast, the answer should be no: <あし> 'feet' vs. <あめ> 'candy' is, from a lexical point of view, not "more" different from each other than <danken> and <tanken>. <し> /shi/ and <め> /me/, even though their phonological correspondence is not segmental, seem to do just the same job graphematically as do <d> and <t>. Lexical contrast, thus, is not bound to phonological segmentality.

Note that phonological minimal pairs such as <あの> *ano* 'that' vs. <あと> *ato* 'after', in which the contrast is established by the graphemes <の> /no/ vs. <と> /to/, can only be expressed by distinct basic shapes that represent the whole syllable. The segmental contrast /n/ vs. /t/ cannot be expressed. What, in these basic shapes, corresponds to the consonant and what corresponds to the vowel can, thus, not be determined logically (consider for comparison abugidas, in which this is possible, cf. Section 2.3.2).

To sum up, from a strictly autonomous, structuralist point of view, there exist autonomously discovered graphematic minimal pairs in the Japanese writing system. The graphemes that they uncover distinguish meaning, but do not bear meaning. If their linguistic correspondence is considered, it is obvious that they represent phonological syllables. In Japanese, the minimally contrastive units of writing, which are graphetically segmental, are thus "larger", i.e. informationally richer than the minimally contrastive units of speech. This raises the following question: in Japanese, and in extension in other languages employing syllabic writing systems, does the difference in the informational size of graphematically vs. phonologically contrastive units make phonology and graphematics different?

Let us now turn to Chinese and address the question of how the procedure of identifying graphemes intra-graphematically by means of minimal pairs might work there. This will require even more stretching of the notion of "minimal pairs" than was necessary for the Japanese writing system. Firstly, if the deciding criterion still is "being a minimal lexical contrast", in order to find minimal pairs in Chinese, in most cases, what is needed is only two graphetic segments: take <我> *wǒ*[169] 'I' and <你> *nǐ* 'you'. These basic shapes mark a lexical contrast, i.e. they are graphemes. The reason these mere segments can distinguish meaning is that they simultaneously *bear* meaning (see below). What is a feature of the Chinese writing system, however, is the internal complexity of a large proportion of graphemes. Examples are <河> *hé* 'river' and <汗> *hàn* 'sweat'. In this minimal pair, the minimally lexically contrastive units are subsegmental. As already evident in the translations of these two morphemes, which are simultaneously independent words, both their meanings are associated with water. Indeed, they share the semantic component (or *radical*) <氵 > which transparently indicates precisely this semantic information: 'having to do with water'. It is derived from the standalone character for 'water', which is <水> *shuǐ*. Since this component appears in both graphemes, the contrast in the minimal pair is constituted by their other (phonological) subcomponents. If the analogical definition of the grapheme is adhered to rigorously, in addition to the simply structured graphemes (such as <水>), these subsegmental components must also be treated as graphemes of the Chinese writing system since they minimally mark a lexical contrast.

The same goes for the grapheme <马> *mǎ* 'horse'. It is a grapheme on its own. It bears meaning, thereby automatically distinguishes meaning, and is not complexly structured as it contains only a single component. Simultaneously, since language is doubly articulated, it has a phonological representation, which is how it can serve as a phonological component as in the graphemes <妈> *mā* 'mother' or <犸> *mǎ* 'mammoth'. Here, analogously to the water-examples above, one subsegmental component is invariant. Here, it is the phonological rather than the semantic component, but the components' function is not relevant at this point. In all of these examples, from an analogical point of view, one stable component helps identify the other, contrasting components as subsegmental graphemes.

To sum up: if Chinese graphemes are to be discovered analogously to morphemes, then Chinese graphemes can either be structurally simple such as <水> or <马>, or they can be structurally complex, as <河> or <妈>. A pressing question in this context is whether these structurally complex graphemes are actually two graphemes instead, which is claimed by Sproat (2000) and DeFrancis (1989) (see below). Note that none of the minimal pairs described above is a minimal pair in the traditional sense. As in Japanese, in Chinese, too, graphemes cannot distinguish meaning parallel to how phonemes can. While phonemes, by definition, highlight phonologically *segmental* differences that are lexically contrastive, in Chinese, graphematically *segmental* contrasts, prototypically, are constituted by the fact that graphemes themselves bear meaning. This, again, might imply that the analogical view reveals graphemes that simultaneously conform to the opposing referential view, since in this example of Chinese, graphemes could be regarded as *written morphemes* or *written materializations of morphemes*. If this is accepted in this form – and the analysis almost does not allow for any other interpretation – then the question poses itself whether graphemes in segmental phonographic writing systems could not serve as written materializations of phonemes as well, which is what the analogical view rejects.

When considering Chinese, what speaks in favor of the autonomous view is that there exist subsegmental graphemes that do not straightforwardly represent morphemes.

At first glance, indeed, there appears to exist no submorphemic (= phonological) level at which writing can distinguish meaning in the Chinese writing system. A special case is made by the phonological components or *phonetics*,[170] however. They are lexically contrastive, but

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[169] The phonological representations stem from Mandarin, which is only one Chinese variety. The meanings of the morphemes are constant throughout all Chinese varieties, however, which is the reason why users of these different varieties, whose spoken modalities are mutually unintelligible, can communicate through the written modality.

[170] These phonological components are the key to arguments that the Chinese writing system is also inherently phonographic (cf. DeFrancis 1989).

not on the grounds of their meaning. Although in their original, segmental form, they represent morphemes, such as the above-mentioned <马>, which stands for 'horse', when used as phonological components, they are desemanticized and used only for their phonological representation. However, crucially, in order to function as clues to pronunciation, these phonological components still have to be interpreted as morphographic, since it is only their representation of a specific morpheme, in this case 'horse', that activates a phonological representation. The clue to pronunciation, thus, is not direct, but indirectly mediated through morphology.[171] If, now, two components are 'crammed' together into one segmental space such as <妈>, the result represents a single morpheme, just like the simple graphemes such as <马>, from which the components derived, do. Consequently, in many cases, two (or more) graphemes discovered by the analogous methodology together represent only one morpheme. Accordingly, the referential view, which would define graphemes based on their representation of morphemes, would fail to capture their internal complexity. This, despite all of the challenges that Chinese poses for it, is the most convincing evidence in favor of an analogical conception of the grapheme. However, below, in my own definition of the grapheme, I critically reevaluate the analogical view and conclude that these subsegmental components of Chinese characters might not be individual graphemes after all.

As we have seen, in Chinese, the discrepancy between how meaning is distinguished in speech and in writing is even bigger than in Japanese. If – and that seems reasonable – we assume that there is a unit *grapheme* not only in segmental writing systems, but other types of writing systems as well, then what becomes evident is that in non-segmental systems, there exists an asymmetry between the levels at which (lexical) meaning is distinguished in phonology and graphematics, respectively. If the graphematic discovery procedures described for Japanese and Chinese above are accepted, then the written modality of these languages is less fine-grained than the spoken modality as it is deprived of some of the contrasts that are available in phonology. Is it necessary that writing and speech have the same contrastive possibilities at their disposal? Are they still of equal weight in systems in which they do not? To return to the question addressed in Section 2.1: do segmental phonographic systems have a special status? Is writing independent of phonology only in them? And if that seems implausible, it (re-)invites the most pressing question: might writing be structurally dependent on phonology after all? Together with the findings from other sections of this chapter, these questions will be addressed in the epilogue.

What the last few paragraphs have shown is that – with some reservations and necessary changes – it is in principle possible to extend the analogical view to non-alphabetical writing systems. A question that remains, however, is if the analogical graphemes that this view produces are of comparative value. Individually, they serve as descriptive units and are gained without recourse to any other linguistic level except for semantics and the lexicon, as lexical contrasts have to stem from somewhere. Berg (2018: 18), in this context, believes that it is feasible to compare the functional units of the "purely graphematic level" – without mentioning, however, how these units are supposed to be discovered in writing systems other than alphabets. Is the criterion *minimal lexical contrast* fitting for a broader, more universal definition of the grapheme? Below, I argue that it is rather the *representational function* of the graphemes, i.e. representing phonemes or morphemes, rather than their *contrastive function* that marks their basic common denominator, partially since their contrastive function frequently only derives from the representational function.

After having presented the possibilities and restrictions of the analogical view, I want to mention an additional approach that is not analogical, but still autonomous. In his comparative analysis of Scandinavian writing systems, Lindqvist (2001) speaks out in favor of an autono-

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[171] Whether readers of Chinese have stored a desemanticized version of <马> and can immediately (i.e. without recourse to the morphology) access its phonological representation is another question. It is, in any case, a question of processing and not a question of the internal structure of the writing system.

mous conception of the grapheme. However, he rejects the analogical view as he points out one major criticism already mentioned above: transferring the discovery procedure used of revealing phonemes to graphematics is inadequate since graphemes are already segmented, i.e. they do not need to be 'discovered'. Crucially, Lindqvist's approach differs in one fundamental aspect from the analogical view: traditional minimal pairs, i.e. oppositions in written expression that distinguish *existing* words with different meanings, are not of primary interest. Instead, the focus is merely on meaning-altering operations of written expressions. What sounds like a different description for the same method is, in fact, not the same, as for Lindqvist, it is not relevant that the alteration results in an existing word of a language. In other words: if the substitution of a written unit with another written unit renders a difference in meaning, regardless of whether the resulting expression is an actual word of a language, a pseudoword or a nonword, this is a sufficient criterion for Lindqvist to term the two written units graphemes.[172]

He chooses the letter |q| in German to illustrate this: in his approach, by substituting |q| with |b|, for example, the result is *<buer>, which is not an existing word of German (cf. Lindqvist 2001: 9). In the traditional analogical view, only the complex unit <qu> is considered a grapheme because no minimal pairs can be found in which only |q| is substituted, although Lindqvist himself provides the example of the German loanword <Dual> 'dual' which contrasts with <Qual> 'torture', an observation that justifies discussing the graphematic status of |q|, since strictly, a single minimal pair alone should suffice to identify a unit as contrastive.[173] Note, however, that no minimal pair can be found in which the |u| of <qu> is substituted. This, of course, is no problem for Lindqvist, since nonwords like *<Qral> have explanatory power in his approach.

Essentially, Lindqvist agrees with Kohrt (1986), who had addressed the issue of *segmentation* and claimed that the method of assembling minimal pairs in order to discover distinctive units was designed for phonology and not for the discovery of segmental units in alphabetic writing systems, precisely because these units are already segmented. Thus, the traditional analogous strategy of establishing graphematic minimal pairs not only "proves to be a superfluous instrument of alphabetic segmentation that leads to a counterintuitive understanding of the grapheme. [It] also results in the fact that part of the graphotactics find their way into the graphematics"[174] (Lindqvist 2001: 10). Consequently, for him, complex units such as <qu> – and presumably also <ch> and <sch>, although he does not explicitly mention them – are not graphemes themselves, but sequences of graphemes that are products of the graphotactics of a writing system (cf. Section 2.2.2.3). Lindqvist argues that it is the pressure to conform to the methods of the analogical view that results in units such as <qu> being treated as graphemes. It could all be a lot simpler, Lindqvist posits, if the empty spaces between the basic shapes were seen as what they are: visual indicators that separate distinctive units. Accordingly, all the segmental basic shapes that a script inventory offers should *a priori* be seen as graphemes. For Roman script used by the German writing system, this includes problematic cases such as |q|, |c|, and |y|. Allography, then, is for Lindqvist (2001: 8) merely a graphetic matter: if a shape such as |g| is substituted by |ɡ| and this *does not* change the 'meaning' of a word, |g| and |ɡ| are allographs of a grapheme <g>.[175]

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[172] While *pseudowords* conform to the phonotactics and/or the graphotactics of a language, but have no meaning, no lexical entry in this language, *nonwords* violate the phonotactics and/or graphotactics of a language (cf. Ziegler et al. 1997: 760).

[173] Take also <Quelle> 'source' and <Duelle> 'duels' (cf. Günther 1988: 83; Fuhrhop & Peters 2013: 204).

[174] „Die Methode der minimalen Ausdrucksopposition erweist sich aber nicht nur als ein überflüssiges Mittel der alphabetschriftlichen Segmentierung, das zu einem kontraintuitiven Graphemverständnis führt. Auch bewirkt diese Methode, daß ein Teil der Graphotaktik in das Grapheminventar gerät" (Lindqvist 2001: 10).

[175] Note that commonly, a script would not count variants such as |g| and |ɡ| as two different units. This implies that above the level of basic shapes, which are identified visually, there is yet another abstract level: a conventional level that includes all units that are seen as distinctive units of a script; here, |g/ɡ|

It is worth mentioning that Lindqvist (2001: 10) correctly calls out the double standard of minimal pairs with regard to the understanding of 'minimal', for if truly minimal oppositions were of interest, the distinguishing contrast between <backen> 'to bake' and <packen> 'to pack' would be subsegmental: the hasta or head of the basic shapes |b| and |p| changes its position within the segmental space. However, these subsegmental contrasts are usually not of interest for adherents of the analogical view, who focus on discrete segmental units instead (cf. Gallmann 1986: 47). On the other hand, polysegmental contrasts such as <Qualle> 'jellyfish' vs. <Falle> 'trap' *are* of relevance for the analogical view. Contrary to that, for Lindqvist, only segmental contrasts matter and the segmental units that are already visually discernable syntagmatically. As I will show, the linguistic value condition will distinguish segmental graphematic constrasts such as <backen> and <packen> from subsegmental contrasts such as the position of the hasta in |b| vs. |p|.

Let me highlight two of the conceptual problems of Lindqvist's approach. The first one is complementary distribution. Lindqvist argues that not all graphs (basic shapes in my terminology) that are complimentarily distributed are allographs of one grapheme. As an example, he gives |ð| and |d| in Icelandic (cf. Lindqvist 2001: 8). His method of meaning-altering operations turns the existing word <dáð> 'deed' to the nonword *<ðad>. Note that this is not a classic minimal pair, as two segments were simultaneously altered in that they were switched. Since *<ðad> is a nonword, Linqvist considers <ð> and <d> to be different graphemes. But consider a textbook example of allography from Greek: |ς|, lowercase sigma, occurs only in word-final position, while the variant |σ| is used everywhere else, resulting in complementary distribution (cf. Coulmas 1996a: 9). The word <σας> *sas* 'you (pers. pron., 2nd pers., pl., acc. or dat.)' illustrates this. If one of the units is substituted, this results in *<ςας> or *<σασ>, and if both units are commuted, which is what Lindqvist did in his example, this results in *<ςασ>. In each case, the result is an incorrectly 'spelled' word. These words are neither graphematically nor, in extension, orthographically licensed because the graphotactics of the writing system are violated.

The question is what Lindqvist defines as nonwords. All of the 'incorrectly' written Greek words listed above still refer to the phonological representation /sas/, the same representation yielded by the orthographically correct spelling <σας>. Thus, they represent the same meaning and word. If this criterion, i.e. the fact that these basic shapes both represent the phoneme /s/, is a reason for Lindqvist to treat |ς| and |σ| as allographs of a grapheme <σ>,[176] then this exposes his approach as adhering to the referential view, for graphically, |ς| and |σ| are distinct, and they are related only with respect to their potential of referring to the same phoneme. If, however, Lindqvist would treat *<ςασ> as a nonword, then <ς> and <σ> would be treated as independent graphemes, which would go against virtually all descriptions of the Greek writing system. It would also imply – as stated above – that there is no place for complimentarily distributed allographs in his conception and that the only kind of allography is free allography as in |g| vs. |ɡ|.

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would be listed as one unit. This level seemingly corresponds with what Lindqvist treats as *graphemes*. It is not a graphetic level since |g| and |ɡ| differ visually, and it is not a graphematic level since the fact that the unit |g/ɡ| is listed in a script does not reveal anything about its possible reference to a linguistic level. It is indeed a conventional level that merely gives an answer to the question "which are the elements of a script"? This is what Valkama (2017) calls *conventional segmentation*. Under this heading, she subsumes questions such as "which units are taught in schools?, which units have names?, how are dictionaries organized?, which units are used on keyboards?". Unlike |g| and |ɡ|, |ς| and |σ| are listed as distinct but related units of the Greek script. They are always listed together because they refer to the same linguistic unit, and they are distinct not primarily because they differ visually, but because they are distributed complimentarily. Thus, unlike |g| and |ɡ|, both |ς| and |σ| are needed and cannot be substituted by one another.

176 The use of |σ| for the designation of the grapheme <σ> is a fairly arbitrary choice. Since graphemes are abstract units, it serves only as a placeholder, and it is chosen for being the allograph occurring in more contexts. It could, however, also be <ς>. An inclusive but more cumbersome version could be <σ/ς>, or, in conceptions in which the case-distinction is not seen as graphematically distinctive, even <Σ/σ/ς>.

The second problem concerns the question of how a unit can be identified as a grapheme in Lindqvist's approach if visual (pre-)segmentation is a sufficient criterion. As illustrated by the example <*buer> that he takes to explain that <q> in the source word <quer> is a grapheme, a unit's potential to alter meaning by substitution is enough to be classified as a grapheme. However, since *<buer> is not a word (or a morpheme), and thus no meaningful linguistic unit,[177] the question is how this example can explain that <b> is a grapheme. It must be noted that Lindqvist does not explicitly mention that turning <quer> into *<buer> identifies *both* <q> and <b> as graphemes, focusing only on <q> which is part of the starting point of the operation, the existing word <quer>. However, it is strongly implied that both the substituted as well as the substituting segments are treated as graphemes. What, thus, makes a given basic shape part of a legitimate, real grapheme, part of a grapheme inventory of a writing system? And what distinguishes it from (1) other classes of units available in a given writing system, (2) units of different writing systems, or even (3) scribbles and symbols that are not considered writing? What follows is a thought experiment: one could take a symbol or a basic shape from a different script, say the symbol |♥| or the basic shape |з| from Cyrillic script, and use them to replace graphemes of German graphematic words: the operation turning German <froh> 'glad' into *<♥roh> or *<зroh> results in nonwords and, thus, in Lindqvist's spirit, changes of 'meaning'. This would most certainly identify <f> and possibly <♥> and <з> as graphemes. The latter two are, however, clearly not part of the German writing system.

Leaving aside these loans from different systems, take system-internal units of German such as the punctuation mark <;> or the digit <8>. Both *<;roh> and *<8roh> are also nonwords. What Lindqvist fails to explain is how |♥|, |з|, |;| or |8|,[178] all visual marks and capable of deriving nonsense words, can be differentiated from <f>. If it is the violation of the graphotactics of the system, he does not mention this explicitly (cf. Section 2.2.1.2 for Bredel's features to distinguish different classes of basic shapes, which include their combinatorics). This implies that Lindqvist works with a preconceived classification of which class of visually segmented 'graphs' can possibly serve as the visual part of graphemes, namely – in his analysis of Scandinavian writing systems – what I call scriptual basic shapes: the basic shapes of the respective script, in this case Roman script (cf. Section 2.2.1.2). Otherwise, as explained above, all visual marks could possibly serve as graphemes since they potentially derive nonwords.

Now, given the peculiarity of granting nonwords explanatory power, Lindqvist in fact immediately identifies *all* scriptual basic shapes used in a writing system as graphemes. His meaning-altering operations are not revealing since, as explained, they alone cannot exclude other visual units such as |;| or |8| and there is no definition of 'nonword'. Simultaneously, only 'letters', basic shapes of Roman script (with writing system-specific additions), are considered, although other graphetic material is also used in the writing system. The result is that only letters are graphemes, and more so: *all* letters are graphemes. The units that result from this "discovery procedure" are not of value in a comparative grapholinguistic perspective, as what would be compared is in fact simply the basic shapes of different scripts that are, because of their segmentality and their ability to alter "meaning", automatically assigned graphematic status. In general, Lindqvist's approach is, even in a description of a single system, not a fitting way of determining graphemes, but instead just a method of discovering allographs: if a unit is substituted and this operation does *not* alter the meaning of a word, the substituted unit and the substituting unit must be allographs. Thus, |g| and |ɡ| are allographs, since substituting one with the other does not change the meaning of a word, precisely because they convey the same

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177 Note, however, that it is a licensed sequence of two graphotactically well-formed syllables: <bu.er>. It is thus a pseudoword and not a nonword of German.

178 Two of these basic shapes are actually in use in some non-licensed spellings of the German writing system: in <♥-lich Willkommen!> 'cordial welcome', |♥| stands for the morpheme (and its phonological representation) {herz} 'heart' which forms part of the adjective *herzlich* 'cordial'. An example for |8| is the rebus spelling <Gute N8!> 'Good night', where <8> is used for its phonological representation /aχt/ as a part of the word *Nacht* /naχt/ 'night'. |8| is also used this way in English in <l8> /leɪt/.

information, *they represent the same linguistic unit*. This type of allography is graphematically not relevant, which is evident in the fact that when the units of a script are listed, only one of them – |g| or |g| – will be listed, not both. They are primarily variants of a unit of a script and only secondarily variants of a grapheme. In sum, graphemes can only be recognized as graphemes because they in some way represent language.

Note that Lindqvist, with his approach, is in the minority. What it elucidates, however, is that not only the referential view is dependent on the phoneme, but also the analogical view, in that it relies on the same methods of discovery that are used to identify phonemes. Here, too, without the definition of the phoneme, there would be no definition of the grapheme. *Analogical*, thus, does not automatically equal *autonomous*, the same way that *referential* does not equal *dependent*. And just like that, we find ourselves again in the position of critically reevaluating the relation of writing to both speech and language and what a prospective answer to this question could mean for the definition of the grapheme. This time around, let us step out of our Eurocentric bubble and take into account non-alphabetic writing systems as well, something neither the referential nor the analogical view have done to a satisfying degree. This will finally result in a concept and definition of grapheme that can be put to work in a comparative analysis of writing systems.

An old and new definition of the grapheme

The fact that both the referential and the analogical view only cater to alphabetic – and partially, also other phonographic – writing systems by relying on the phoneme, a unit that is not at the forefront of all types of writing systems, leads to the present attempt of defining the grapheme cross-grapholinguistically. To highlight its importance, the central reasons that make this enterprise necessary and the possible benefits it entails shall be repeated. Firstly, if we take writing as the starting point of analysis – and I strongly believe a theory of writing should do that – it is a simple fact that in every writing system, regardless of how much it differs from other systems, there exists a minimal unit of writing. This does not imply that uncovering or deciding what this minimal unit is in each given system is a trivial task – by all means, it is not. All writing has by definition at its core the function of encoding language. This, in my opinion, is reason enough to study the minimal units of writing and comparatively analyze how they serve this function. Secondly, from a generally theoretical and more specifically, linguistic standpoint, positing a unit 'grapheme' only for a single type of writing system – the alphabetic type (which Glück 2016b: 251 does, for example) – is a "restriction that would be hard to imagine in the domain of phonology" (Birk 2013, my translation),[179] and not only phonology, but many other linguistic domains as well. It would be untenable to suggest a definition of the phoneme or the morpheme that applies only to one linguistic type or even only to one language. Similarly, it is untenable to do the same with the definition of the grapheme. This, however, is the standard procedure in grapholinguistics. Even Kohrt (1986: 91f.), who has produced tremendous work with respect to a definition of the grapheme, states that he does not believe "that 'logograms', 'morphograms' and 'phonograms' are to be considered as different appearances of one and the same kind and that they should be subsumed under the notion 'grapheme'". Others have not dismissed the idea of a more inclusive and general definition of the grapheme, such as Sproat (2000: 25, emphasis in original), who writes "I will use the term *grapheme* to denote a basic symbol of a writing system; […] I […] merely use the term *grapheme* as a convenient short way of saying 'basic symbol of a writing system'". Without going into detail about what *grapheme* means for Sproat, it is noteworthy that he chooses to treat it as applicable to any writing system.[180] I intend to do the same, but given the theoretical orienta-

[179] „[…] eine Einschränkung, wie sie im Bereich der Phonologie nur schwer vorstellbar ist" (Birk 2013).

[180] He adds, however, that "in discussing some writing systems we may use the term grapheme in slightly different ways depending upon how fine-grained an analysis is being assumed" (Sproat 2000: 25).

tion of this study, I consider it necessary to deal with the details. What is the grapheme when we take into account vastly different writing systems?

Before explaining them separately, let me list the conditions that have to be met in order to speak of a *grapheme*: (1) *It needs to distinguish meaning*. This corresponds with what analogists envisioned the grapheme to be: a contrastive unit. Note, however, that this is only one of a number of conditions that have to be met *simultaneously*. Thus, the analogical view, as I have stated before, was only partially accurate. What is also noteworthy is that their function of distinguishing meaning does not preclude graphemes to also *bear* meaning, which is the case in morphographic writing systems. This is not a prerequisite, but also not an exclusion criterion, since a unit that bears meaning (cf. the morpheme) *automatically* also differentiates meaning,[181] and that is the decisive criterion. (2) *It represents a linguistic unit.* This is the point where it gets tricky and controversial. Of course, this – at least at first glance – in principle corresponds with what is claimed in the referential view. There are, however, notable exceptions: the direction of analysis is, exclusively, *from writing to language*. Phoneme or morpheme inventories, thus, are not of concern, and the written units that correspond with *all* phonemes or *all* morphemes of these inventories do not need to be identified. This also leads to the third and final condition: (3) *It needs to be a minimal unit.* Consequently, German <ng>, just because it refers to the phoneme /ŋ/, is not a grapheme, since it is not a minimal unit. This differentiates it from <ch>, since its parts are *both* independent graphemes themselves: <n> and <g> are graphemes, whereas in <ch>, only <h> is an independent grapheme, and |c| is not. It is an interesting observation that in the writing systems of the world, contrastive units that themselves do not represent linguistic units – such as |c| in German – are a very rare phenomenon. The definition of the grapheme should not be based on exceptions, and German, English, and other alphabetic writing systems have upheld their unjustified status as bases for theoretical models for too long. Table 2 at the end of this section offers examples from various writing systems that highlight how the three conditions apply.

Condition (1): **Lexical distinctiveness criterion.** Graphemes differentiate meaning. Following the analogical view, this condition can be tested using minimal pairs. However, unlike in Lindqvist's (2001) approach, both words that form a minimal pair must be existing words of a language – non-words or pseudowords do not count. In German, for example, this leads to minimal pairs such as <Saum> and <Baum>, but also <Schaum> and <Baum>, where the contrast of <s> and <b> and corresponding /s/ and /b/ (correspondences we are, however, not yet concerned with) is segmental, while the contrast <sch> (for /ʃ/) vs. <b> – at least for the first part of the minimal pair – is polysegmental. Cases such as <Schaum> will need to be disambiguated by condition (3).

Condition (2): **Linguistic value criterion**. While condition (1) basically corresponds with the analogists' view, condition (2) conforms to referentialists' claims: a grapheme represents a linguistic unit, although this is not limited to phonemes.[182] However, it is paramount to note

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This reflects that even though Sproat intends to use the same term for all writing systems, he is aware of the differences it entails in different writing systems.

[181] One interesting question that I cannot and do not want to give an answer to but still raise here is if synonyms that, from a denotative point of view, are semantically identical (if there even is such a thing) could be seen as allomorphs, i.e. different materializations of the same underlying morpheme. Allomorphy is most often discussed in the context of grammatical morphemes, but can lexical morphemes with the same meaning but different substances be allomorphs, too? That would mean that synonyms in Chinese, for example, that mean "exactly the same" but have different phonological representations, could be either written with one grapheme (this would speak for synonyms being allomorphs) or with two graphemes (this would speak for them being separate morphemes). In any case, if there are two distinct graphemes and switching them out does *not* alter the meaning of an utterance since they are synonyms, does that mean the statement "a unit that bears meaning automatically distinguishes meaning" is false?

[182] An anonymous reviewer of an abstract I submitted noted that the term 'linguistic unit' is problematic when used for phonemes, since phonemes do not have a meaning such as morphemes or words. The

that the fact that in a minimal graphematic relation, which is constituted by graphemes, a basic shape must represent at least one linguistic unit, does not imply that inversely, every linguistic unit must be represented by a basic shape. Indeed, the analytical direction relevant here is *basic shape → linguistic unit*. Thus, I agree with the analogists' critique that assuming graphemes such as <a>, <ah>, <aa>, etc. for the phoneme /a/ or a polysegmental grapheme <ng> for the phoneme /ŋ/ is superfluous. However, in the graphemes that have been discovered using the analogical method, which are logically much fewer in number than the referential graphemes, the basic shapes also represent linguistic units, this was just not the defining criterion. In fact, in German, the basic shape |c| is, on its own, not the signans of a grapheme. It *does* differentiate meaning, cf. <denken> 'to think' vs. <decken> 'to cover', which means condition (1) is met (cf. Rezec 2013: 231). Interestingly, however, even analogists claim that |c| is not a grapheme and justify this with its distribution: in native[183] German words, it never occurs without <k> or <h>. A possible and rather probable explanation for this distribution that the analogists somehow never explicate directly is that |c| alone – again, in native words – does not represent a phoneme, whereas <ch> /x/ and <ck> /k/ do. While the second of those is not a grapheme since it can be explained suprasegmentally, being syllabically determined much like <ff> discussed above, <ch> *is* a grapheme of German. It differentiates meaning and it has a linguistic value. But is it minimal? Why is <ch> a grapheme of German and <ng> is not? This is where condition (3) comes into play.

Where both conditions (1) and (2) get fuzzy is when it comes to punctuation, and this is why I choose not to merely speak of linguistic units, but linguistic value or information in general. Punctuation signs such as the period or the comma definitely have the potential to distinguish meaning, but what they represent remains rather abstract since it pertains to higher linguistic levels – the syntactic, the pragmatic, the prosodic (cf. Section 2.2.2.5). Consequently, condition (2) is not final as yet. A more detailed discussion will have to critically reflect whether punctuation marks are to be treated as graphemes and what this means for the definition of the grapheme. Also, it is not only punctuation marks, but other types of graphetic variation that have graphematic potential as well, be it bold or cursive print, underlining, color, or other types of visual design choices. They have been called graphemes in the past (cf. Gallmann 1985) and have been granted, analogously to prosodic features in phonology, the status of suprasegmentals (cf. Günther 1988). It is safe to say that these latter types of graphematic functions are not encompassed by the grapheme, but segments such as punctuation marks, digits, special characters, etc. will definitely have to be accounted for. However, depending on what exactly a grapheme represents – whether it is a single, concrete linguistic unit or instead linguistic information or a linguistic function – it will be imperative to assume different classes of graphemes that cannot be categorized together. I leave this open for future discussion.

Condition (3): **Minimality criterion**. A crucial problem in discussing this condition is the understanding of 'minimality'. Something that has been postulated firmly above is that the graphemes of any given writing system should be identified based on the written side of the equation, not the linguistic side. This implies that what is minimal is, if not completely, then at least to a large degree, determined graphetically – visually, that is. This underlines that graphematics can never be analyzed completely divorced from graphetics. Similarly to Lindqvist's (2001) approach, the first step that needs to be undertaken is to gather basic shapes. The *basic shape* was posited as the central unit of scripts and, thus, graphetics (cf. Section 2.2.1). Basic shapes themselves are not yet categorized – as letters or characters, digits, punctuation signs, or special characters. Visually, there is no categorical difference between <2> and <Z> – it is a matter of graphematic competence to know that they are part of different inventories (cf. Section 2.2.2.5). Thus, at this point, they are all basic shapes, including also non-linguistic signs

reviewer's reading of 'unit' probably already insinuates a sign, whereas by 'linguistic unit', I simply mean a constitutive unit of language, and cenemic units such as phonemes or syllables are units of this kind, too.

183 It does occur alone in loanwords such as <Clown> 'clown' or <Cello> 'cello'.

such as the symbol |♥| discussed above. One of the central features of a basic shape that can be evaluated independently from its graphematic status is its segmentality. A basic shape occupies exactly one segmental space of the writing surface. If we proceed descriptively and collect all the segmental graphetic material from a product of writing, it can be tested whether these gathered basic shapes meet conditions (1) and (2). In German, a sequence of two basic shapes such as |ng| is not a grapheme <ng> since myriad minimal pairs can be found where only one of the segments is substituted: <Bank> 'bank' vs. <bang> 'anxious', <bang> vs. <Band> 'tape', <bang> vs. <Balg> 'brat'. Thus, the fact that the sequence <ng> represents the phoneme /ŋ/ is not decisive since condition (1) is already met for its constituents (cf. Berg 2018: 20, who argues similarly). In this vein, following Fuhrhop & Peters (2013: 205), the much-debated sequence <sch> should not be considered a grapheme in German since minimal pairs can be found for both <s> and <ch>: <Masche> 'bow' vs. <manche> 'some' vs. <Maske> 'mask'. The situation is different for <ch> and <qu>. Here, no minimal pairs can be found for the individual segments – at least not *both* of them. For <qu>, the |q| can be substituted in a very limited range of minimal pairs, including <Quelle> vs. <Duelle>, as already cited above. However, the <u> can never be substituted; thus, |q| alone is not a grapheme since by itself, it does not differentiate meaning. It also does not meet condition (2) as it alone does not represent any linguistic unit. In these cases where one segment is not a grapheme itself – or more segments combined are not graphemes individually – the units are conceptually still treated as graphemes although graphetically, <ch> and <qu> are polysegmental. To summarize, a minimal unit is either a segment for which conditions (1) or (2) apply or a sequence of segments, in which for at least one of the segments, conditions (1) and (2) do not apply. Graphetically, these latter sequences are not minimal, while graphematically, they are.

One problem that remains in the definition of the grapheme has already been addressed in the context of Lindqvist's approach: subsegmentality. If the grapheme is supposed to be the "minimal" contrastive unit, then why is not the hasta in |b| vs. |p| a grapheme, or the lowest horizontal stroke of the |E| in |E| vs. |F|?[184] In these cases, the answer is fairly simple: Neither the hasta (or its location) in |b| and |p| nor the stroke in |E| represent linguistic units, i.e. they do not meet condition (2). The picture is a little more complex in Chinese. Reconsider the examples given above, <妈> *mā* 'mother' and <犸> *mǎ* 'mammoth'. Condition (1) tells us that both of the components in each of these two units can differentiate meaning.[185] This speaks in favor of treating the subsegmental components as graphemes. Seen as these two complexly structured units take up only one segmental space each, in Chinese, following the analogical view, subsegmental components – radicals and phonetics – would have to be accepted as graphemes, which is indeed what both DeFrancis (1989) and Sproat (2000) suggest. This is also the crucial difference between a polysegmental sequence of two graphemes such as <ng> and the segmental <妈> *mā* 'mother': whereas in <ng>, both <n> and <g> retain their status as graphetic segments and both have the potential to represent a linguistic unit (a phoneme) individually, in the Chinese example, two characters that are graphemes individually – <女> *nǚ* 'woman' and <马>

[184] Berg (2018: 18), in his autonomous, distributional approach, solves this problem of subsegmentality for the German and English writing systems by preliminarily positing that graphemes have to have at least "the size of a letter". This criterion is highly problematic since it includes in the grapheme definition a preceding definition of "letter". Thus, graphematic or at least conventional knowledge is necessary in order to know how "large" a grapheme can be. I argue that in a truly autonomous fashion, this problem could simply be solved by resorting to a purely graphetic criterion, i.e. the spatial cartography of the writing surface. "At least the size of a letter" then becomes "at least a segmental space", whereby the necessity of defining "letter" is avoided and the definition becomes at once applicable cross-grapholinguistically. However, as we will see (for Arabic and Thai, for example), this definition is, unfortunately, not accurate, as subsegmental basic shapes can also serve as graphemes. In any case, Berg himself refined his definition of the grapheme and got rid of the problematic "size of a letter" part by relying on the fact that only syllabically autonomous units can be graphemes.

[185] However, these components only form minimal pairs with other subsegmental components. <妈> *mā* 'mother' and <犸> *mǎ* 'mammoth' are a minimal pair, but <妈> *mā* 'mother' vs. <马> *mǎ* 'horse' are not.

mǎ 'horse' – are crammed together in one segmental space. The question is, however, do they still individually conform to condition (2) when they are part of a new, complex structure? One of the subsegmental components in these examples indicates meaning, although in a fairly abstract way, by signaling an approximate semantic clue. The other component, different in its functionality, signals the pronunciation of a character. Prototypical graphemes in Chinese represent morphemes, and neither of these components does that: in <妈> *mā*, the <女> *nǚ*-part, in this case, refers to the signatum-side of the morpheme ("woman"), but it is not in every complex grapheme that the semantic component straightforwardly points to the right morpheme, it can also be intransparent in this respect (cf. Ho, Ng & Ng 2003). Other examples given above were <河> *hé* 'river' and <汗> *hàn* 'sweat'. In this pair, the water-radical only indicates semantic affiliation, but the specific signatum of the grapheme <水> *shuǐ* 'water' is blurred in the process.[186] The other component in <妈> *mā*, <马> *mǎ*, is used as a phonetic, i.e. only for its phonological representation. It contributes the signans of the morpheme it originally represented. As I argued above, for the reader, recognizing the morpheme that the original segmental grapheme represented is necessary to even get to the phonological representation that the morpheme is associated with. However, the signatum of the morpheme 'horse' is completely disregarded in the final complex grapheme, <妈> *mā*. Much like <ng>, which conforms to condition (2) by representing the phoneme /ŋ/, the graphemes <妈> *mā* and <河> *hé* represent morphemes on their own. However, their components, at least in their minimized sizes and sometimes altered forms, cannot stand alone like <n> and <g> can. One is tempted to argue that in a grapheme such as <妈> *mā* 'mother', the semantic component represents the signatum of the morpheme, while the phonological component represents the signans of the morpheme. However, as we saw, it is not as simple as that: semantic components often only give a vague clue as to the meaning of a morpheme, and due to language change, the clues to the pronunciation that the phonological components give have also frequently become opaque.

In sum, I argue that characters of the type <妈> *mā* and <河> *hé* are complex graphemes rather than sequences of two graphemes because the two initially independent graphemes that are shrunk in size and 'crammed' into one segmental space (and in this size, cannot occur alone) change their function, i.e. condition (2): they no longer represent morphemes, and this distinguishes the subsegmental components fundamentally from their individual segmental counterparts which are graphemes.[187] However, as this discussion highlighted, it cannot be denied that in Chinese, there exists a subsegmental *graphematic* level, which means that elements smaller than graphetic segments have a graphematic value of some sort. This is similar to what Primus (2004, 2006) proposed for the German writing system or more generally, every writing system using Roman script. Also, what this proves is that in Chinese, there are features of writing that cannot be explained by phonology or other linguistic levels: the inner systematics of these complex graphemes – one component signaling meaning, the other pronunciation – are a genuine graphematic feature that has no parallel in any other linguistic level.

As implied above, with respect to the discussion about subsegmentality, it would be convenient to postulate that only segmental basic shapes can function as graphemes. However, writing systems such as Arabic and Thai, with their subsegmental vowel graphemes (even if in Arabic, they are optional), prove this claim wrong. In a sequence such as Thai <ดี> /diː/ 'good',

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[186] In this example, it is also evident that the initial basic shape, if used as a subsegmental component, significantly changes its form. This visualizes the shift in identity from an independent, segmental grapheme to a subsegmental part of a grapheme.

[187] Thus, Daniels's (2018: 168) objection that "there would be two entirely different kinds of grapheme in the writing system, the semantic ones and the phonetic ones, and they would only achieve specific reference in combination" and that "this also leaves the residue of non-composed characters to get some sort of separate description" is not valid. Not every functional graphematic element has to be a grapheme. The fact that composed graphemes in Chinese are complex is something we need to be aware of in a graphematic analysis, but it does not mean that we have to treat them differently than non-composed graphemes. Both of them differentiate meaning, both of them refer to linguistic units (morphemes), and – as elaborated – both of them meet these specific conditions in a minimal manner.

for example, the two graphemes representing the phonemes /d/ and /iː/, respectively, share one segmental space – at least from a horizontal point of view. Vertically, one could argue that the basic shape that functions as the vowel grapheme is positioned in a different vertical space than the primary consonant grapheme. Korean is another extreme example: here, all of the graphemes are graphetically subsegmental as the segmental space is filled with graphematic clusters that represent phonological syllables (cf. Section 2.3.2). However, they unambiguously refer to linguistic units (phonemes), which makes them different from the subsegmental components in Chinese that work only compositionally.

Table 2: Conditions for the grapheme definition applied to units from different writing systems; graphemes are highlighted in grey

	condition (1)	**condition (2)**	**condition (3)**
German <ng>	+	+ phoneme /ŋ/	– both <n> and <g> are already graphemes
German <ch>	+	+ phoneme /ç/	+
German <sch>	+	+	– both <s> and <ch> are already graphemes
German |c|	+ <denkt> vs. <deckt>	–	+
German |I| (hasta) in <p> vs. <b>	+	–	+
Chinese <河> 'river'	+	+ morpheme {river}	+
Chinese |氵|	+	– semantic component 'water', which itself represents no linguistic unit	+
Thai <ด>	+	+ phoneme /d/	+
Thai <◌ิ>	+	+ phoneme /i/	+
Korean <ㄱ>	+	+ phoneme /k/	+
Korean <각>	+	+ syllable /kak/	– is made up of three graphemes that represent phonemes, respectively
Japanese <き>	+	+ mora /ki/	+

My proposal for a more universal conception of the grapheme is precisely that: a *proposal*, and I do not claim that it is the (only) right one. Like Berg (2018: 22), I also want to advocate for more composure in the discussion of grapheme definitions. It does not make sense to speak of "one grapheme inventory" of a given writing system, as different conceptions arrive at different – and possibly equally justified – inventories. As different analyses are driven by distinct epistemological interests, it would be unfair to proclaim *a priori* that only one method is the right one. All I want to say is that for a comparison of typologically highly diverse writing systems, my conception outlined above seems to be a reasonable fit.

2.2.2.2 Graphetic variation, graphematic variation, and allography

Quite unsurprisingly, as there has never been an accepted definition of the grapheme, there has also been "no general theoretical model for categorizing graphs as allographs of a grapheme in a given writing system" (Coulmas 1996a: 174). A concept inherent to allography, which was coined in analogy with *allophony*, is *variation*: allographs are always variants of something. Therefore, this section will treat both graphetic as well as graphematic variation and describe the respective types of allography constituted by them.

Graphetic variation is ubiquitous. This becomes obvious when considering that chirographically, every literate person has individual handwriting and typographically, hundreds of thousands of typefaces exist for various scripts that all differ in some visual respects. Both of these types of variation could be seen as *idiolectal* in the sense of being specific ways of writing for given individuals (cf. Ammon 2016: 279): even though there may be remarkable similarities, the concrete appearance of handwriting usually differs from individual to individual, even if only slightly. If the materialized graphs operate within the categorical perceptual boundaries of the abstract basic shapes,[188] handwriting even allows for conscious style *choices*. Because of the peculiarities of its production, handwriting is not constant, but rather dynamic. The graphs that are materialized and that can be assigned to one basic shape will never be exactly the same. For example, when writing the word <banana> by hand, three different graphs of the basic shape |a| will have been produced. There is a theoretical possibility that two graphs instantiating the same basic shape look exactly the same, but the possibility that they differ visually is much greater in handwriting than in print, i.e. typographically produced writing.[189] Typefaces are constant. In print, therefore, the conscious style choice is the choice of typeface itself, and this choice precedes the writing (or typing) process. As such, what is idiolectal is not the typeface itself, but the choice of a specific typeface.[190] Once a typeface has been chosen, the graphs that are assigned to one basic shape are visually constant. Conceptually, they are still concrete material manifestations and as such, they are physically never *exactly* the same, but visually, and thus, perceptually, they are characterized by constancy.

The appearance of both handwriting and print can be seen as a suprasegmental feature of writing. The abstract basic shapes need to be materialized *somehow*, and a given handwriting or typeface accomplishes this task. Hamp (1959: 2) compares typefaces to "the acoustics of a room, or the detailed physiology of a speaker, so far as language is affected" and discards them as "scarcely even cultural". With this view, he neglects the functions that typefaces can serve independently of the language that is represented by writing. As demonstrated by the example of *typographic mimicry* in Figure 8 (page 106), neglecting the functions of the graphetic module of writing – even if they are 'paralinguistic' – means that the overall analysis of writing falls short.

On top of a concrete materialization in handwriting or with the help of typefaces, other suprasegmental types of variation can operate, for example bold print or italics (mostly in ty-

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188 Sometimes, basic shapes do not even have to operate within these categorical perceptual boundaries, as the graphematic context can disambiguate. If a word such as <unumgänglich> 'inevitable' is written in handwriting, the first four basic shapes, two instances of |u| and an |n| and |m|, respectively, might become visually indiscriminable in some styles of handwriting, but in the context of the whole word, the rest of the graphs likely provide sufficient information to recognize and distinguish the first four graphs that might be visually very similar and to assign them to basic shapes and, in turn, to graphemes.

189 This claim must be relativized. Even when set in the same typeface, different graphs of a basic shape can differ within the same printed product of writing. Just to give an example: when the ink of a printer is slowly running dry, the color and quality and even shape of the individual graphs on a page might differ noticeably (Andi Gredig pers. comm.).

190 But here, people simply might not change the default typeface preset in an application, for example Calibri (or in the past Times New Roman) in Microsoft Word, which means they have not actively chosen a typeface.

pography) or underlining (both in typography and chirography), but also suprasegmental capitalization (both in typography and chirography).

As established before, graphetic variation is not denotative in the classic sense (cf. Section 2.2.1). It can be connotative as evidenced by the examples of typographic mimicry, or functional on a different level than the denotatively linguistic. If one word in a sentence is printed in italics, cf. <I do *not* believe this is true.>, the main function of this visual feature is to indicate a contrast, to conceptually distinguish the word printed in italics from the other words. The function is thus contrastive, and it only works suprasegmentally, as in isolation, this contrast would not work – visually, it would not exist. Even if this contrastive suprasegmental function can be interpreted as linguistic, as it most certainly involves linguistic levels – the textual, the pragmatic, the discourse level –, it is not regarded as classically denotative, since the sequence of graphemes in <*not*> still corresponds with both the same phonological representation as well as with the same semantics as the upright, non-italicized <not>. Italics or not, that does not matter in this case. Graphetic variation, in sum, can be seen as functional *and* linguistic or, in a narrow sense, at least communicative, although its functions operate on different levels than the functions of graphematic variation discussed below.

For the first reading of allography, which I term *graphetic allography*, we need to return to segmental graphetic variation: a given basic shape such as |a| can be materially instantiated by an infinite number of different graphs in different individual styles of handwriting and different typefaces. At this level, we are only concerned with visual similarity: if two graphs look sufficiently similar in that they both materialize the abstract visual configurations of the same basic shape, they are instantiations of that basic shape. Two subtypes of allography are subsumed here: first, the *intra-inventory type of graphetic allography* that was mentioned in the context of writing <banana>. Whether in handwriting or in print, when the word <banana> is materialized, three graphs associated with the basic shape |a| will have been produced. However, as it is not common (although it is certainly possible) to change the handwriting or the typeface *within* a word, the three instantiations will be members of the same handwriting or typeface inventory. In contrast, the second subtype of allography at this level is when different handwritings or different typefaces are concerned: in the three instantiations <banana>, <banana>, and <banana>, distinguished by the use of fonts, we have three different graphs that are associated with the basic shape |a|: |a|, |a|, and |a|. In this case, because these three graphs belong to different inventories (= typefaces), we speak of *inter-inventory graphetic allography*. It is paradigmatic in nature. Note that inter-inventory graphetic allography subsumes intra-inventory allography, as in <banana>, for example, again, three graphetic allographs of |a| are produced.

To analyze other types of allography, the graphematic level must be considered. At this level, three types of *graphematic allography* need to be distinguished. The categories that constitute these three types are the following: (1) *intra-inventory* vs. *inter-inventory*, (2) *free* vs. *positional*, (3) *externally determined* vs. *externally independent*. Something that will be not considered as allographic in the narrow sense is *orthographic variation* (see Section 2.2.3). However, for the distinction graphematic vs. orthographic allography, the criterion (4) systematic vs. normative could be assumed.

The first type of allography is referred to as *inter-inventory free (externally independent) allography*. It is exemplified by the pairs of basic shapes |a| vs. |ɑ| and |g| vs. |g|, respectively. At first glance, they might appear like cases of graphetic variation. However, visual similarity is not the deciding factor here. Basic shapes, including these four, are defined by the number of elementary forms, their relative size, and their arrangement in space. In these regards, |a| vs. |ɑ| differ, and so do |g| vs. |g|, but also |b| as characteristic for print and |𝒷| as characteristic for cursive handwriting. In order to count as graphetic allographs, two graphs cannot differ in the number, relative size, and spatial arrangement of their elementary forms.[191] *Basic shapes*, on the other hand, cannot be grouped together based on visual criteria alone. Note that, for example, nothing makes |ɑ| more similar to |a| than for example to |o|. Visual criteria, thus, could lead to wrong groupings. This makes this type of variation *graphematic*, and what is decisive is the assignment to one grapheme. The two basic shapes |a| vs. |ɑ| are assigned to the same grapheme <a>. Individually, they do not meet the lexical distinctiveness criterion – in pairs such as <ask> and <ɑsk>, they do not differentiate meaning. With respect to the linguistic value criterion, in a given writing system, they both prototypically represent the same linguistic unit, for example the phoneme /a/. They can substitute each other, but, crucially, they do that only across inventories: they are paradigmatic inter-inventory allographs. As such, they are complementarily distributed with respect to inventories.

If a typeface uses |a|, it will not simultaneously use |ɑ| – with the exception of different styles of typefaces, as in Times New Roman, for example, where the roman (as in ‘upright, non-italicized’ and not as in ‘Roman script’) variant uses |a|, and the italic variant uses |*a*| (cf. Rezec 2013: 245-247). Herrick (1974: 11) even remarks that the latter basic shape, |ɑ|, is “considered typical of the suprasegmental grapheme ‘italics’”. Styles, however, can also be seen as different inventories. In principle, the choice between |a| and |ɑ| is free, but it is dependent on the inventory that is chosen – and within an inventory, it is constant. In this vein, Rezec (2013: 245) speaks of consistency rules, which can be illustrated with the example ?<Saɑl> ‘hall’ which looks strange to the eye (cf. Meletis 2015: 49). A hypothesis for handwriting would be that people who use |a| stick to it – at least intra-textually, although this can change as handwriting styles evolve over time. Also, there is no restriction claiming that even within one text, a person cannot freely alternate between |a| and |ɑ|, although, as mentioned, this is commonly perceived as uncommon.

The second type of graphematic allography, undoubtedly the type most often referred to in the literature, can be termed *intra-inventory positional (externally independent) allography*. For this type of graphematic allography, it is not as tempting to assume visual reasoning, at least in the example called upon here which uses the visually dissimilar basic shapes |ς| and |σ|. Both of these shapes are units of Greek script. Both occur within the same text instantiated in the same graphetic inventory (typeface or handwriting), so they are certainly intra-inventory allographs. An example would be the above-mentioned word <σας> in which they both occur. Individually, they meet the lexical distinctiveness criterion, i.e. they differentiate meaning. However, no minimal pair |ς| vs. |σ| can be established since the two shapes always occupy different positions: |σ| occurs word-initially and word-medially, while |ς| only occurs word-finally. This makes these basic shapes positional allographs. They are complementarily distributed with respect to word position, or more generally, what was listed as category (2) above: free vs. positional. Both of these shapes are in a graphematic relation with the same linguistic unit: the phoneme /s/. Thus, the linguistic value criterion connects rather than separates them. However, as I will argue below, this criterion alone does not suffice to assume allography, as for example in German, <f> and sometimes <v> or <ph> also represent the same linguistic unit, the phoneme /f/. However, <ph> is not a grapheme because it is not minimal, and for <f> and <v>, minimal pairs can be found, individually and in all positions. Thus, not only because of their representation of the same linguistic unit but also because of their complementary distribution, |ς| vs. |σ| are allographs of a grapheme <σ>. One of the other well-known examples for this type are the allographs of the Arabic writing system, as Arabic graphemes have positional variants: there is always a free (or isolated) shape of a grapheme and there are connected (or ligated)

[191] There must be some space for visual variation inside the graphetic solution space, however, otherwise we would not be able to categorically perceive different graphs as members of one basic shape (cf. Section 2.2.1.2). This variation is often of geometric nature, i.e. the relative size/length of the elementary forms differs from one graph to another, cf. |A| vs. |A|. In the latter, the horizontal stroke in the middle of the basic shape is short in length, which is why the two diagonal strokes are closer together. This is an example of geometrical variation, which is perceptually less salient (cf. Changizi et al. 2006: E119).

shapes that are dependent on whether they are positioned initially, medially (in the middle of two other basic shapes) or finally in a string of basic shapes. An example is the grapheme <ب>: |ب| is its isolated form, |بـ| its initial form, |ـبـ| its medial form and |ـب| its final form. A number of graphemes, <و ز ر ذ د ا>, do not have allographs that connect to the left (the writing direction), so they only have two allographs: a free form and a form that connects to the right (cf. Majidi 1996: 5).

In Chinese, there exist so-called *variant characters* or *yìtǐzì* (異體字), i.e. alternate forms or basic shapes that represent the same morpheme. Galambos (2015) provides examples: |峰| and |峯| for *fēng* 'mountain top', |群| and |羣| for *qún* 'group, flock', and |册| and |冊| *cè* for 'booklet' as well as |裏| and |裡| for *lǐ* 'inside'. Here, visually dissimilar basic shapes are in graphematic relations with the same morpheme. However, their use is not positionally restricted and not complimentarily distributed – it is free. While it might seem odd to readers if two different variants are used within the same text, in theory, such a use is licensed. Therefore, we here have an instance for *intra-inventory free (externally independent) allography*.

What remains is a fourth type of allography that is controversially debated in the literature. It concerns only those writing systems whose scripts offer two cases: uppercase basic shapes (or majuscules) and lowercase basic shapes (or minuscule). This includes the Roman, Cyrillic, Greek, and Armenian scripts and the question whether the upper- and lowercase basic shapes conventionally paired together are two separate graphemes or rather allographs. For English, Sampson (2015: 16, emphasis in original) claims unequivocally that "<g> and <G> would not belong to a single grapheme; […] the upper versus lower case distinction is significant in our script". For German, in which the picture of capitalization is even more complicated, there are two different opinions. One side argues that case is contrastive and thus upper- and lowercase basic shapes belong to two different graphemes, as minimal pairs can be found: <Arme> 'arms' vs. <arme> 'poor (adjective)'. Others contend that the capitalization of words at the beginning of sentences as well as within a sentence can be explained with recourse to other linguistic levels (cf. Fuhrhop & Peters 2013: 207f.). There are various other types of capitalization Fuhrhop & Peters list for German: capitalization of address pronouns (*Sie/Ihre*), capitalization of proper nouns, capitalization of conventionalized idioms (such as *Schwarzes Brett*), and all caps.

Sentence-initial capitalization is what unifies all writing systems whose scripts offer uppercase variants. In this position, majuscules function to signify the start of a graphematic sentence (cf. Section 2.2.2.5). What we have here, thus, is clearly a form of positional variation and complementary distribution – minuscules can never start a sentence. Sentence-initial capitalization is, thus, just like |ς| and |σ| outlined above, a form of intra-inventory positional (externally independent) allography.

However, sentence-internally, where the lowercase shapes are the default (cf. Primus 2006: 9), capitalization can also occur, e.g. in the form of all caps. If a whole word in a graphematic sentence is capitalized, as in <I do NOT believe this!>, then this represents a form of *suprasegmental graphematic variation*. Similar to highlighting a string of text in bold print or italics, it changes the visual appearance of a word (or any sequence of segmental units). However, in bold print or italics, basic shapes are kept intact (with some exceptions, cf. |a| vs. |*ɑ*| within one typeface, see above), which is why in these cases, we speak of graphetic variation. In contrast, rendering a string in all caps means switching out lowercase basic shapes with respective uppercase basic shapes associated with the same grapheme, which is a graphematic matter.

The capitalization of address pronouns can be explained pragmatically, and orthographically, since capitalizing them is simply an orthographic convention. For German, this leaves one critical case open for discussion: sentence-internal capitalization. While some attribute it to the noun as a part of speech, claiming all nouns require capitalization, this constitutes a rather problematic explanation. Instead, a syntactic explanation has largely superseded it: the heads of noun phrases are capitalized (Primus 2010: 30; Maas 1992).

Evidently, basically all of the contexts in which capitalization occurs are determined by external criteria – syntactic, orthographic, etc. Category (3), externally determined vs. externally independent, subsumes all these contexts of capitalization in German. All of them are cases of *intra-inventory positional externally determined allography*, with the external determinator unspecified as it must be evaluated distinctly for each type. They are deemed positional because they are in complementary distribution: take a sentence-internal capitalized noun such as <Essen> in <Das Essen schmeckt gut.> 'The food tastes good'. Here, the lowercase version <essen> is not orthographically licensed. Neither is the random capitalization of individual basic shapes that are not word-internal, so it would be incorrect to write *<Das EssEn schmeckt gut.>.[192] Uppercase basic shapes have their contexts and lowercase basic shapes have their contexts.

Now that different types of allography have been established, I want to elaborate on what allography is not. In the literature, there appear to exist a few misconceptions about allography that are closely linked to the referential definition of the grapheme (cf. Section 2.2.2.1 and Garbe's conception of 'allograph'). In this context, graphemes that have the potential to represent the same linguistic unit are often mistaken as allographs. As anticipated above, I want to argue that <f>, <v>, and <ph> are *not* allographs of a grapheme <f> in German. <ph> is disqualified since <p> and <h> are already graphemes individually. Also, when they occur word-internally and do not correspond with /f/, they are separated by a morpheme (and syllable) boundary, cf. English <hop.head>, German <Knapp.heit> 'shortage', <Desktop.hintergrund> 'wallpaper', <Top.hits> 'top hits'. Also, the sequence <ph> can sometimes be substituted by <v>, resulting in a difference in meaning due to the fact that <v> also represents /v/: <Phase> 'phase' vs. <Vase> 'vase'. In cases in which they do represent the same phoneme /f/, graphematic 'minimal' pairs are possible, too: <Phon> 'phone' vs. <von> 'from'.[193] But what about <f> and <v>? They are not allographs only because <f> always and <v> sometimes represents /f/. Unlike for |ς| and |σ|, there are minimal pairs (if only a few) in which they both represent the same phoneme, such as <Vetter> 'cousin' vs. <fetter> 'fatter (comparative of fat)', <viel> 'much' vs. <fiel> '(he) fell', <Feilchen> 'little file' vs. <Veilchen> 'violet'. Additionally, there are minimal pairs where <v> and <f> refer to /v/ and /f/, respectively, such as <Verse> 'verses' vs. <Ferse> 'heel' or <Vokal> 'vowel' vs. <fokal> 'focal'. Evidently, <f> and <v> can occur in the same positions in the syllable and the word, although their distributions are not symmetrical.[194]

Another difference between <f> and <v> and |ς| and |σ| is that the latter two *always* represent the same linguistic unit. They do not have the potential to represent different linguistic units, both are maximally transparent (cf. Section 3.3.1.4). In the case of <f> and <v>, <f> corresponds with /f/ and thus meets the linguistic value criterion of my proposed grapheme definition. This correspondence is unambiguous and context-free (cf. Neef 2005: 56). For <v>, the picture is different: it commonly also refers to /v/, a phoneme that is, however, unmarkedly referred to by <w>. Neef (2005: 69-71) speaks of an underdetermined correspondence rule with regard to <v>, which sometimes refers to /f/, sometimes to /v/. <v>, thus, has no stable linguistic unit that it represents. This is not a problem for the linguistic value criterion, since for that criterion to be met, <v> only has to minimally represent a linguistic unit. This, crucially, does not preclude it from also representing other linguistic units in different contexts. I argue that in order to be allographs of one grapheme <f/v>, |f| and |v| would have to have stable correspond-

192 The all caps version <Das ESSEN schmeckt gut.> would, however, be licensed. Here, the uppercase basic shapes cease to have any grammatical function and, as a suprasegmental form of highlighting, serve other functions instead.

193 Note that this is not technically a minimal pair as there are two basic shapes that together form a contrastive graphematic sequence instead of only one grapheme (such as <f>) that contrasts with <v>. Also, while graphematically, it is the consonant(s) in the onset that form a contrast, phonologically, it is the vowel: <Phon> has the phonological representation /foːn/ while <von> is decoded as /fɔn/.

194 In word-final position, <v> is very rare. It mostly occurs in the suffix <-iv> as in <attraktiv> 'attractive'. Note that here, it corresponds with /f/ because of final obstruent devoicing in German. In other forms of the paradigm, it represents /v/ as in <attraktive> since the syllable boundary precedes is: <attrakti.ve>.

ences with a single linguistic unit, e.g. the phoneme /f/ – just as |a| and |ɑ|, |ς| and |σ|, and |N| and |n| do, respectively. There should not be any contrastive minimal pairs, either because they do not occur in the same position (which they do) or because they are in free variation (which they are not).

Analogous examples of what allography is not come from the highly complex Thai writing system. In Thai, the existence of 42 basic shapes that are being used to represent only 21 consonant phonemes results in a multi-grapheme-phoneme-correspondence: more than one grapheme refers to a single phoneme. However, there exist minimal pairs, e.g. words with the same phonological representations but different meanings (= homophones) that are spelled differently. They could be termed homophonic heterographs. This means that even though two basic shapes represent the same phoneme, they belong to two different graphemes, similar to <v> and <f> in <v̲iel> and <f̲iel> (see above). Take the words <พาย> /phaay/ 'paddle' and <ภาย> /phaay/ 'part (of space or time)' (cf. Brown 1988: 44). They only differ in one grapheme, <พ> vs. <ภ>. Even though these basic shapes represent the same phoneme, and, unlike <v>, represent *only* that phoneme, what we have here are still two distinct graphemes since there exist minimal pairs. These types of homophones that are spelled distinctively are treated extensively by Brown (1988: Chapter 4).

One type of allography that is marginal as it falls out of the realm of graphematics is *orthographic allography*. All of the types of allography described above are (4) systematic. 'Orthographic allographs' do not fit neatly into this picture. Firstly, I would argue that they commonly encompass units larger than graphemes. Above, I stated that <ph> cannot be an allograph of <f>, even though in most cases, it also corresponds with /f/. In German orthography, however, they are treated as variants, and one can choose between <Typographie> and <Typografie>. German orthography allows a choice when it comes to writing <ph> or <f> in what are historically loanwords, so both <Orthographie> as well as <Orthografie> or <Photo> and <Foto> are allowed. However, the Duden states that the spellings with <f> are to be favored (cf. Duden 2017: 15). There are many other codified words that have more than one spelling. In some cases, these words not only differ in one segment but are different in more than one respect (such as <Majonäse> and <Mayonnaise> 'mayonnaise', where the former was deemed incorrect in a recent reform, however, Duden 2017: 18). This latter form of variation, however, even though Berg (2016a) defines it as graphematic variation, is not central for the concept of allography.

2.2.2.3 Graphe(ma)tic syllable and graphotactics

As described in the previous sections, in the German grapholinguistic literature, the wish for an autonomous graphematics has been strong. The autonomous concept of a graphematic syllable that was established in this context is demonstrative proof of this. 'Syllable', in this vein, is not to be interpreted as 'phonological syllable', but, starting with Primus (2003), as a modality-independent suprasegmental unit of any linguistic modality. For German (and, crucially, German sign language, which is its own language distinct from German), she posits respective syllabic structures for the signed, spoken, and written modalities.[195] Her general definition of the syllable is indifferent to the modality in which it is produced: rather, it is based on an alternation between more and less salient units (cf. Primus 2003: 7). What exactly is defined as salient is modality- or, more specifically, substance-specific. In speech, it is that which is more sonorous, in sign language it is movements (rather than locations) and in Roman script, it is that which is

[195] Sign language is its own language system in which the primary modality is signed (and an optional modality might be writing), whereas speech and writing are two modalities of the same language system. Correspondences between speech and writing are, thus, system-internal. In contrast, correspondences between sign language and speech or sign language and writing (if it is not the written modality of the signed system, e.g. SignWriting) are system-external, i.e. translations (cf. Meletis 2017; Section 2.1).

marked by the feature [+length], that is, basic shapes that have visible ascenders or descenders that extend beyond the central space, such as |b| or |q|.

This conception of a graphematic syllable dates back to works of the late 1980s (Eisenberg 1989; Naumann 1989) in which it was observed that plosives occurring at syllable edges are represented in writing by basic shapes that exhibit descenders as in |p| or ascenders as in |b|, while vowels that occur in syllable nuclei are written with basic shapes such as |a| or |e| that only extend over the central space of the line and are called 'compact'. Visual length, thus, indicates phonological syllable boundaries. Independently of Primus (2004, 2006), who also studied correlations between graphetic features and phonological features, but with very compatible results, Fuhrhop & Buchmann (2009) segmented the minuscule basic shapes of Roman script and concluded that all of them consist of a head (or hasta) and a coda, a finding going back to the work of Brekle (1995) and his *hasta-coda-principle*. In |d|, for example, the head is the vertical stroke |l| and the coda is the curve |c|. The following criteria are relevant for the definition of the graphematic syllable:

a. Every letter has a head (cf. Primus 2004).
b. Every grapheme has a coda.
c. The head is the vertical segment which spans the central space by the shortest distance and may exceed it.
d. The coda is located in only one space (either central, upper, or lower space).

(Fuhrhop, Buchmann & Berg 2011: 279)

A crucial assumption in the development of the graphematic syllable is that the notion of length, previously conceived of as a binary feature [±length], is scalar rather than absolute (cf. Fuhrhop & Buchmann 2009: 138). Accordingly, all lowercase basic shapes of Roman script can be placed on a continuum of length, the so-called *length hierarchy* (cf. Figure 18). This hierarchy is supposed to have "the same epistemological status in graphematics as the sonority hierarchy in phonology" (Fuhrhop, Buchmann & Berg 2011: 277).

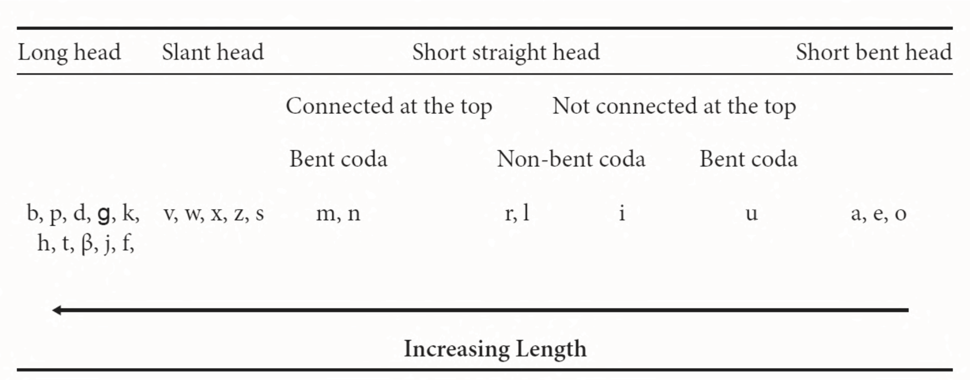

Figure 18: Length hierarchy (from Fuhrhop, Buchmann & Berg 2011: 282)

Analogous to the sonority sequencing principle in phonology, a length sequencing principle (LSP) is assumed in graphematics: "The graphematic syllable core is occupied by the most compact grapheme.[196] The length of the segments increases monotonously toward both syllable edges" (Fuhrhop, Buchmann & Berg 2011: 283).[197] Examples for graphematic syllables in German that do not violate the LSP are <ver>, <lo>, and <ren> for the word <verloren> 'lost' or <le> and <sen> for <lesen> 'to read' (cf. Schmidt 2014: 254). One of the most interesting observations that have been made about German and English graphematic syllables is how they can violate the LSP: in German, it is the basic shapes |s|, |h|, and |y| as well as the combination |tz| that lead to violations, as in the words <**s**paren> 'save', <flie**h**st> '(you) flee', <S**y**stem> 'sys-

[196] Note the problematic use of *grapheme* when what is referred to is actually the basic shape.

[197] Cf. also Eisenberg (1989: 66), who already formulated such a principle, although he did not operate with the parameter *Länge* 'length', calling it *Schwere* 'weight' instead.

tem', and <pla**tz**en> 'burst', respectively (cf. Fuhrhop & Buchmann 2016: 362-366, 368). In English, it is |s| as in <**s**peak>, |h| as in <s**h**ame>, and |y| as in <rh**y**thm>. Most of these violations, however, can be explained, and some of them have even been functionalized (for details see Fuhrhop & Buchmann 2016; Fuhrhop, Buchmann & Berg 2011; Schmidt 2014).

As Fuhrhop & Schmidt (2014: 566) illustrate, diachronic changes have led to an emergence and strengthening of the present graphematic syllable structure: a demonstrative example is the gradual elimination of non-compact basic shapes such as |v|, |j|, and |y| from the syllable nucleus. This observation, including the questions of why and how these changes occurred, is one of the questions treated by the prospective Natural Grapholinguistics.

Up until this point, the graphematic syllable is an autonomous unit of writing, defined with purely visual means. In the German writing system, it is the smallest unit that can occur on its own,[198] and it can simultaneously be a graphematic word and – according to Fuhrhop & Peters (2013: 216) – also a graphematic sentence.[199] Since up to this point, the graphematic syllable was solely defined using graphetic criteria, the relations between the graphematic syllable and phonological syllables, but also with morphemes, have not been taken into consideration yet. As Fuhrhop & Peters (2013: 228) note, in German, there exist many parallels between graphematic syllables and phonological syllables, although there are also notable differences. Frequently, a word has the same number of graphematic syllables and phonological syllables. Consider German <legen> 'to put, place' (cf. Fuhrhop & Peters 2013: 228). Analogously to the phonological syllabification in /le.gən/ or /le.gn/, depending on whether the /n/ serves as a syllable nucleus, the graphematic syllabification could be <le.gen>, although the morphologically motivated alternative <leg.en> is also possible and does not violate the LSP.

Differences between the two concepts of syllable, now, can be found in the marking of vowels: graphematically, vowels are always represented, with the exception of contractions as in <geht's> *lit.* 'it is going' where the apostrophe indicates an omitted vowel of a separate word, the <e> in <es>. Consequently, the nuclei of graphematic syllables are always vowels. In contrast, phonologically, sonorants can also serve as syllable nuclei, as seen in /le.gn/. Two more differences are mentioned by Fuhrhop & Peters (2013: 228): in German phonology, null onsets are forbidden, and words commonly do not begin with vowels, since glottal stops are almost always inserted before them. Since the glottal stop, which is most often not interpreted as a phoneme of German (cf. Wiese 1996: 16, 58), is not graphematically represented, graphematic syllables can have a zero onset: <alle> 'all', <ulkig> 'peculiar', <endlos> 'endless'. Inversely, the second syllables of German words often exhibit an onset graphematically, as in <Ru.he> 'silence', whereas phonologically, the corresponding syllables have a null onset.[200] Differences can also be found in the treatment of consonants which are phonologically ambisyllabic: the /t/ in /ˈmɪtə/ 'middle', for example, is ambisyllabic, i.e. simultaneously part of both syllables. In writing, the consonant is doubled as in <Mitte>, and the two instances of <t> are part of two distinct graphematic syllables (cf. Schmidt 2018: 32).

After this treatment of the graphematic syllable in German and, partially, also English, writing systems using Roman script (for additional examples from French, cf. Fuhrhop & Buchmann 2016), the question of what a syllable-like unit could look like in writing systems employing scripts other than Roman should be addressed. When considering other writing systems

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[198] There is one example of a grapheme in German that can stand alone, the very seldom occurring vocative-<O> as in <O Tannenbaum!>, which is the original German title of the Christmas song 'O Christmas tree' (cf. Fuhrhop 2008: 199). More modernly, it is also written <Oh> as in <Oh mein Gott!> 'Oh my God!' (cf. Fuhrhop & Peters 2013: 251). Note, however, that this grapheme is also a graphematic syllable, so the claim that graphematic syllables are the smallest units that can occur on their own is still accurate.

[199] I argue that in order to count as a graphematic sentence, it would – at least in German (but not in Thai, for example) – need to also include a punctuation mark. The graphematic sentence will be discussed in detail in Section 2.2.2.5.

[200] Note that <Ru.he> is also a morpheme boundary (cf. Veronika Mattes pers.comm.).

that use basic shapes for correspondence with both consonant and vowel phonemes, that is, alphabets, it can be observed that there exist different ways in which the visual criterion of length – in the form of ascenders and descenders that extend beyond the central space – expresses itself. Consider the Greek, Armenian, and Cyrillic scripts.[201] According to the *empty space criterion* (cf. Section 2.2.1.2), the first empty space that is perceivable is the one between basic shapes or ‘letters’; the next one is the empty space between one-dimensional graphetic sequences. Preliminarily, it can be stated that in alphabets, these larger units correspond mainly with words and will be discussed in the next section. The question is whether there is also a visual feature that makes units *within* this one-dimensional graphetic sequence visually discernible. Certainly, in every one of these scripts, the feature [±length] can be discovered, but it remains to be analyzed what exactly it does in each of the systems.

In the Greek script as used for the Modern Greek writing system, [±length] appears to indicate syllable boundaries exactly as it does in German and English (cf. Primus & Wagner 2013: 43). Three minuscule basic shapes of the Greek script have an ascender: |δ θ λ|, eight have a descender: |γ η μ ρ ς φ χ ψ[202]|, and three basic shapes have both: |β ζ ξ|. Of the remaining basic shapes, six are prototypically used for vowel graphemes: |α ε ι ο υ ω|, while five are used for consonant graphemes: |κ ν π σ τ|. Consider the example <λεξικό> /lɛ.ksi.ˈkɔ/ ‘dictionary’, syllabified as <λε.ξι.κό>. Here, only the last syllable, <κό> does not straightforwardly conform to the LSP. Note that at this point, the interpretation of the [±length] feature in Greek is only vague, and further analysis of the length hierarchy as in German might yield that |κ| exhibits more length on a continuum than |ό|.[203] In other examples, such as <ελληνικός> /ɛ.li.ni.ˈkɔs/ ‘Greek (adj. masc.)’, syllabified as <ελ.λη.νι.κός> or <γράμμα> /ˈɣra.ma/ ‘letter’, syllabified as <γράμ.μα>, the same tendency can be witnessed. Determining whether the graphematic syllable can be assumed for Greek the same way it is postulated for German and English is beyond the scope of this thesis, but these few examples point to the possibility. If the graphematic syllable is indeed a relevant unit in Greek as well, it is an interesting question for further research whether the length hierarchy in Roman script is a hereditary feature that developed diachronically out of Greek script. Visual similarity of some basic shapes could have been given up or modified in the course of the development, with the principle of visually signaling syllables remaining intact.

In Cyrillic, the picture is drastically different. Considering the variant of the script used for Russian (other variants have different sets of basic shapes), only one basic shape has an ascender: |б|, five have a descender: |д р у ц щ|,[204] and one has both: |ф|. All the other basic shapes, regardless of whether they are used in vowel or consonant graphemes, are compact: |а в г е ж з и й к л м н о п с т х ч ш ы э ю я|.[205] Consider the following example:

[201] The unicase Georgian script is another candidate for such an analysis, as even more of its basic shapes exhibit the feature [length] than in Armenian. Of the 33 basic shapes, only four are compact: |ა თ ი ო|. Twelve basic shapes have an ascender: |ბ ზ მ ნ პ რ ს შ ჩ ძ წ ჰ|, 13 have a descender: |გ დ ე ვ კ ლ ქ უ ფ ღ ყ ც ჯ|, four have both: |ტ ჟ ხ ჭ|. This indicates that [±length] plays a vital role in the Georgian writing system, although this would have to be proven in further studies.

[202] In the font used here, |ψ| has an ascender, too. Prototypically, however, this basic shape only has a descender.

[203] In Greek, as is evident from these examples, stress is also graphematically marked. This adds visual information in the high subspace of the linear space, which, possibly, could also affect an analysis of the [±length] feature.

[204] It is a legitimate question whether the ‘hooks’ in |д ц щ| are really descenders, as they do not extend into the lower space of the line as much as other descenders as in |р у| do (cf. Gordon 2006: 301). This is why Gordon (2006: 36) prefers the term ‘dangling’ instead of ‘descending’ for them. For |д|, he also treats the hooks as ‘vertical serifs’, which is interesting as for Roman script, serifs were classified as non-distinctive (cf. Primus 2006: 9). If this applied to the Cyrillic script, too, then a |д| without the hooks would only be a ‘sans serif’ variant. For |щ|, however, this does not work, as eliminating the hook would result in a different basic shape which is used for a distinct grapheme: |ш|.

[205] As with the marking of stress in Greek, the diacritic on |й| is debatable with respect to [±length].

<Алфавиты на основе кириллицы являются или являлись системой письменности для 108 естественных языков.>

Transliteration: *Alfavity na osnove kirillicy javljajutsja ili javljalis' sistemoj pis'mennosti dlja 108 estestvennych jazykov.*

'Alphabets on the basis of the Cyrillic script are or have been writing systems for 108 natural languages.'

In this example, the units that are separated by empty spaces of the second order ('word spaces') do not appear to have any further internal visual organization. Yes, in a word such as <алфавит> *alfavit* 'alphabet', |ф| does (in this case doubly) exhibit the feature [+length], and here, it correlates with a syllable boundary: <ал.фа.вит>, but the other basic shapes that have the same feature do not have the same function, especially |у| which is in a graphematic relation with a vowel (= a syllable nucleus), and which greatly disrupts the picture: <русский> *russkij* 'Russian', syllabified as <рус.ский>. Here, |р| does not violate a potential LSP for the Cyrillic script, but |у| does so quite ostentatiously. Again, this analysis is highly preliminary, as no sophisticated segmentation and subsequent hierarchization of segments of Cyrillic basic shapes have been undertaken yet. For this script, too, thus, a length hierarchy remains a desideratum. Even if at a first glance, visually, it seems improbable, there could hypothetically still be a length continuum. However, even if there were a continuum, it would not be visually as salient as the ones characterized above. As for the Roman or Greek scripts, inner-graphematically, there might be a system at work in Cyrillic and its crucial feature could be termed 'length', but the function that is ascribed to this feature – *visually* segmenting (graphematic) syllables – is not fulfilled.

The Armenian script – which has both upper- and lowercase basic shapes – is a special case, as of 39 lowercase basic shapes, only seven do not have an ascender or a descender. These are |ա ո ռ ս տ օ ւ|. Interestingly, only four of them are used for vowel graphemes, while the other three are used for consonant graphemes. Sixteen letters have descenders: |բ գ դ զ ը թ լ ղ յ շ չ պ ջ ր ց ք|, ten have ascenders: |ե է ժ ծ հ ձ ճ մ ն և|, six have both: |ի խ կ վ փ ֆ|. Again, if the syllable structure of Armenian is analyzed – only visually, without a subsegmental analysis of the constituents of the basic shapes –, length seems to play some role in graphematic syllabification: for example, in the word <համալսարան> *hamalsaran* 'university', syllabified as <հա.մալ.սա.րան> <ha.mal.sa.ran>, long basic shapes only occur at the syllable edges. The same holds for <վերարկու> *verarku* 'coat', syllabified as <վե.րար.կու> <ve.rar.ku>. Here, the second basic shape and simultaneously the nucleus of the first syllable, <ե>, has an ascender. In this case, this is not a grave violation of the LSP since the nucleus in this case also represents the end of a syllable, but if the syllable were to instead feature an additional final non-long basic shape, this would definitely count as a violation of the LSP. When considering a greater variety of examples, it becomes clearer that only a few basic shapes violate the LSP, as in <անձնագիր> *and͡znagiɾ* 'passport', syllabified as <անձ.նա.գիր> <ɑnd͡z.nɑ.giɾ>, where it is the basic shapes |ն| and |ի| that violate it. The tendency that shows itself in this very preliminary analysis is that length is of some importance in signifying graphematic syllables in the Armenian writing system.

Arabic and Thai are writing systems that are segmental, but not alphabetic (cf. Section 2.3.2). Visually, in these systems, there are no discernable units below the one-dimensional graphetic sequence.[206] There are, arguably, syllabic structures in writing, but they can only be revealed through a graphematic (i.e. not a solely graphetic) analysis. Also, the graphematic syllable structures in these systems roughly correspond with their phonological syllable structures.

[206] McCawley (1994: 122), in his treatment of graphotactics, describes a *graphic syllable* for Hindi. His definition of graphic syllable is similar to Fuhrhop's and colleagues' as it is divorced from the concept of the phonological syllable: "The use of the term 'graphic syllable', it should be noted, does not carry with it any presupposition that each graphic syllable represents a phonological syllable; in Hindi, for example, it is common for a word to contain more graphic syllables than it has phonological syllables [...]".

Even if for the above-mentioned alphabets, the feature [±length] distinguishes visually salient and less salient basic shapes, this reliance on visual salience is where things get problematic when a more universal perspective is adopted. As salience is a deciding variable in the modality-independent definition of syllables, and salience is in each case defined substantially (for writing, that means visually), what is salient in different writing systems and the different scripts they employ is subjected to vast variation and variability of visual materiality that is unprecedented for sounds and gestures. This is likely owed to the fact that while speech and sign language are produced without "external" tools, i.e. only parts of our human bodies – our oral articulators, our arms, hands, etc. – are used in production processes, writing is reliant on tools, and our articulators, mainly our hands, in combination with tools, e.g. a pen, do not seem to be subjected to the same limits that the 'mere' articulators are in the production of speech and sign language. In any case, writing is richer in material variation.

In this vein, some authors point to the limitations of a writing system-specific analysis and suggest further studies including other writing systems. In this context, Fuhrhop & Buchmann (2009: 152, my translation) state:

> […] we can make statements about the structure of the graphematic syllable in German, the same can be done for other languages. Afterward, these statements are merged and one possibly arrives at universals (especially with writing systems that operate with the Latin alphabet, other alphabets would be the next step, and in turn the next step would be the comparison with non-alphabets, since in Japanese, the syllables are already the graphemes).[207]

In stating "in Japanese, the syllables are already the graphemes", they are referring to the fact that the basic shapes of the Japanese *kana* inventories are in graphematic relations with phonological syllables and are one type of grapheme in Japanese, the other type being the morphographic *kanji*. At first glance, it appears correct to claim that the graphemes 'are', or better 'represent', syllables. However, in this quote, the terminological vagueness is fatal, as Fuhrhop & Buchmann (2009: 152) presumably do not mean graphematic syllables when they use "syllables", but phonological syllables. This, then, strays from their fundamental question, which – for German – had been whether graphematic syllables can be defined *without* recourse to phonology. The answer is that for Japanese, they cannot.

If, in a first, methodologically autonomous step, the phonology-dependent hypothesis (cf. Section 2.1) is rejected, which it what was done in the assumption of the graphematic syllable for German, and a string of Japanese hiragana basic shapes is merely investigated graphetically, no visual features can be identified that render any units visually more salient than others. An example is the sentence <お腹が空きました>. When only considering the visual form, then – except from the fact that the kanji basic shapes are visually more complex than the hiragana basic shapes in that they are composed of a greater number of strokes[208] – no visual difference can be made out between the basic shapes, in other words: no visually salient "alternation structure" that is constitutive for syllables becomes apparent. There are no different classes of basic shapes in Japanese that showcase visual features similar to [+length] and [−length] which are largely characteristic for basic shapes that are employed for consonant and vowel graphemes in German, respectively. A preliminary conclusion would be that there is no "graphematic syllable" in Japanese. The same applies to all other writing systems that are typologically non-segmental, if segmental writing systems are understood as writing systems in which the smallest written units correspond with segmental linguistic units, e.g. phonemes (cf. Section 2.3.2). In Japanese, evidently, this is not the case, as the smallest, segmental written units represent ei-

[207] „Wir können […] Aussagen machen über die Struktur der Schreibsilbe im Deutschen, das Gleiche kann mit anderen Sprachen gemacht werden. Hinterher fügt man dies zu Aussagen zusammen und kommt möglicherweise zu Universalien (insbesondere mit Schriftsystemen, die mit dem lateinischen Alphabet operieren, andere Alphabete wären dann der nächste Schritt, der übernächste Schritt der Vergleich mit Nicht-Alphabetschriften, im Japanischen sind die Silben ja schon die Grapheme)."

[208] While this might be true for the *kanji* and *kana* in this example, there are also more simple *kanji* with fewer strokes that visually resemble the *kana* basic shapes more closely.

ther syllables or morphemes. The obvious conclusion, in turn, would be that it is determined by the linguistic level that is represented in writing (phoneme, syllable, morpheme, etc.) whether there can be (but does not have to be, cf. Cyrillic above) a visual alternation structure. This would mean that this visual alternation structure, although it is a feature of a writing system's materiality, is *not* autonomous from linguistic levels such as phonology.

In the Japanese syllabaries, there is a transparent and uniform relation between basic shapes and phonological syllables, i.e. the graphemes are biunique. However, because of the aforementioned type mixing and the morphographic *kanji*, there is no consistent grapheme definition *per se*. Only in the *kana* inventories do the empty spaces between the segmental basic shapes simultaneously indicate phonological syllable boundaries. *Kanji*, in contrast, also individually occupy single segmental spaces, and they represent morphemes. However, since native *kun*-readings of morphemes in Japanese can be polysyllabic, one kanji does not always correspond with one syllable (cf. Bhide 2015: 2). Kanji, thus, are only morphographic, but not necessarily morphosyllabic.

The open question, at this point, is whether the segmental graphemes that represent phonological syllables are also 'graphematic syllables' in the sense of the graphematic syllable in German and English that was presented above. Not only for Japanese, but for any given writing system, the central question is, thus, whether it can be accepted that a grapheme is simultaneously a graphematic syllable. There are two theoretical options: (1) one that accepts this possibility, and (2) one that denies it. The definition outlined above clearly states that the graphematic syllable is 'suprasegmental', and this suprasegmentality is visually defined as an alternation of salient vs. less salient basic shapes. Are there exceptions like in phonology, where a single phoneme can serve as a phonological syllable nucleus? It appears so: a single grapheme can, in some systems, presumably serve as a graphematic syllable nucleus, cf. the grapheme <a> (indefinite article as in 'a cat') in English that simultaneously *could* be regarded as a graphematic syllable and a graphematic word, and reconsider the German example <O>.[209] Fuhrhop & Peters (2013: 251) list a number of words in different writing systems that consist of only one grapheme such as French <y> or Spanish <e> or Dutch <u> – noting, however, that these are all function words.[210] This implies that segments, no matter if spoken or written, can be syllables and even words if they fulfill the minimal requirement of being a licensed syllable nucleus. This is where I object on the basis of a narrower, materially defined reading of 'suprasegmental', and introduce a conceptually more fitting term, 'polysegmental'.

A crucial observation regarding frequency and markedness is that in phonology, single-phoneme, that is, segmental phonological syllables are exceptions,[211] as are single-grapheme graphematic syllables in segmental writing systems such as German or English. In the Japanese writing system, however, for the *kana* inventories, which constitute a big part of the system as a whole, single-grapheme graphematic syllables would be the rule. If the criterion 'represents a phonological syllable' is accepted as a deciding factor in accepting that graphemes can simultaneously be graphematic syllables, this deviates from the autonomous, intra-graphematic analysis proposed for the German graphematic syllable. Thus, perhaps counter-intuitively, it must be posited that there exists no visually discernible polysegmental graphetic unit in Japanese that we could be treated as a graphematic syllable similar to the graphematic syllable in German. Phonological syllables are represented by graphemes in Japanese, but, crucially, these are segmental. The designation *syllabic writing system*, thus, is determined by the linguistic value cri-

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209 Arguably, the 'multiple identity' of <a> is not split in equal shares. <a> is primarily a graphematic word, and only then a grapheme, and finally, and least saliently, a graphematic syllable.

210 As Evertz (2016: 393) notes, in English, there exists the so-called *three-letter-rule* which states that a content word must be written with at least three graphemes. Examples for this are <egg>, <bee>, and <pea>.

211 This is accurate at least in that segmental syllables are far outnumbered by polysegmental syllables. Few phonemes in the respective languages of the world have the capacity to serve as syllable nuclei; these are mostly vowels (cf. Vennemann 1988: 27-30).

terion (cf. Section 2.2.2.1), i.e. the linguistic level that is predominantly represented graphematically. The general conclusion for syllabic writing systems is: graphemes, which are prototypically segmental, represent non-segmental phonological syllables. Strikingly, this means there is no graphematic syllable as it was defined here in syllabic writing systems. This will be crucial in my criticism of the phonology-autonomous hypothesis in the epilogue of this chapter, cf. Section 2.4).

The difference between 'suprasegmental' and 'polysegmental' needs to be further addressed, as it is important in the rejection of a graphematic syllable in Japanese and other syllabic writing systems. Any sequence of segments, such as three-grapheme English <all>, is polysegmental. 'Polysegmental', thus, merely refers to the fact that a unit consists of more than one segment. The definition of the graphematic syllable for Roman script depends on the visual length of basic shapes. This feature is not suprasegmental, however, such as vowel length in phonology (cf. Fox 2000: 12-14), for it cannot only be recognized in relation to other units. A <t> always exhibits the feature [+length], an <e> always [−length], and although Fuhrhop & Buchmann (2009) conceived of these terms as scalar, it is the length hierarchy that is scalar, but the basic shape's position on it is absolute. Yet, the definition of 'graphematic syllable' stemming from German literature does not commonly operate on single segments, it is defined as a polysegmental unit which must (largely) conform to the LSP. One-segment graphematic syllables such as English <a> do not violate the LSP, but, as stated above, they are certainly not the rule. If there were only or mainly one-segment graphematic syllables in the German or English writing systems, the graphematic syllable as defined above would be grossly redundant.

Now, for Japanese, one might argue that there exists, in fact, a salient visual marker that allows discerning graphematic syllables: an empty space between them. This view is backed by the argument that in light of the visual diversity of the scripts of the world, a broader spectrum of visual demarcations that signify graphematic syllables should be considered, in other words: 'length' as defined for Roman script cannot be the sole feature fulfilling this function. However, the criterion that prevents the empty space between basic shapes to be interpreted as a graphematic syllable boundary is polysegmentality. Segments are already graphemes and, *visually* speaking, they cannot be graphematic syllables, too.

This raises another crucial question for a theoretical grapholinguistics: if units are defined visually – *graphetically*, that is – without recourse to linguistic units, which is what is done in the definition of the 'graphematic syllable', then why are they not treated as *graphetic* rather than *graphematic* units? Is it not a graphetic syllable rather than a graphematic syllable? And is the feature [±length] not merely an additional feature, allowing a further segmentation of internal chunks of graphetic material within graphetic units that have been identified using the empty space criterion? If this is affirmed, then the graphetic syllable is a polysegmental graphetic unit *inside* another polysegmental graphetic unit (one-dimensional graphetic sequence), which itself is demarcated by empty spaces. If, now, we were to find that these graphetic syllables – whatever feature helps identifying them, e.g. [±length] – mainly correlate with phonological syllables, as the 'graphematic syllable' does in German and English, then is what we have discovered in the end an autonomous unit of writing or instead a reflection of language in writing? If the latter is the case, which is likely, then what we have gained is actually a strong argument in favor of the view that writing is structurally dependent on language, and in this case, phonology.

The fact that in German, the graphematic syllable corresponds mostly with the phonological syllable – a finding going back to Eisenberg (1989), who initially remarked that *visual* length indicated *phonological* syllable boundaries – strongly suggests that the representational view of writing cannot be readily abandoned. Arguably, most of what we elaborately identify as 'autonomous' in writing still has its roots in the fact that what writing does is represent language and make possible written communication. In a nutshell, one could say: just because something like the [±length] feature that is inherent to writing was defined intra-graphemically does not preclude the possibility that it is significantly determined by another level, e.g.

phonology or morphology. To accept that writing represents language is not to dismiss it as its own system complete with its own features. However, conversely, a strong claim such as Zifonun et al.'s (1997: 263) that a 'written syllable' (= *Schreibsilbe* in the German original) can *only* be defined with recourse to the phonological syllable and cannot be identified with graphe(ma)tic features or combinatorial rules must also be rejected. As the previous discussion emphasized, the intra-graphematic (in essence, this means graphetic) analysis is indeed fruitful and tenable. However, in a further analytical step, the overlap with phonology or other linguistic levels cannot be explained away.

This raises some important questions: why is the graphematic syllable as defined by visual salience not as universal as the phonological syllable or the syllable in sign language? Is the reason for the "un-universality" of the graphematic syllable based on substance, i.e. on the fact that only some scripts have the visual resource of offering different classes of basic shapes (e.g. distinguished by the feature [±length]) that allow a visualization of structures alternating in their degree of salience? If this is excluded as a possible reason (and I am not claiming it should be), other possible reasons must be considered. All in all, the type-specificity of the graphematic syllable described above is striking: it is only alphabets that show this kind of visual alternation in the written modality – an alternation that largely corresponds with the alternation of salient vs. less salient units in speech.

Finally, one of the arguments in favor of a graphematic syllable is not primarily linguistic, but perceptual in nature: visually signifying the syllable structure aids the reading process, a pilot study by Drews (2011) shows. This is underlined by Eisenberg (2013: 296), who also claims the graphematic syllable serves perception and, thus, the reader. In perception and reading, proficient readers do not always convert graphematic syllables to phonological syllables, which highlights that visual materiality is relevant in its own right. This is a point that will be discussed further in Chapter 3.

Polysegmentality as defined above is not only central to syllabic structures in writing, it is also a prerequisite leading to a necessary examination of the concept of *graphotactics* or *graphotactic constraints*, "restrictions on ways in which the elements of a writing system may combine with each other" (cf. McCawley 1994: 115; cf. also Voeste 2004). Graphotactics treats rules that state which basic shape combinations as well as grapheme combinations or distributions are licensed or possible within a writing system (cf. Stalph 1989: 23). On a different level, it also evaluates combinations of elementary forms within basic shapes. As such, graphotactics is a necessity on the graphetic level for the formation of well-formed basic shapes as well as on a graphematic level for the formation of well-formed units of writing larger than graphemes. These larger units do not start with the graphematic syllable, as the discussion of graphotactics in the section on the graphotactic syllable may insinuate, since *any sequence* of two or more segments can be evaluated graphotactically, regardless of whether it is already a graphematic syllable or not. The question here is, once again, whether graphotactic constraints echo phonotactic constraints (or morphotactic constraints in morphographic writing systems), or whether they can be described autonomously, as Günther (1988: 77) claims. As with the definition of the grapheme, both views are accurate in different respects. Graphotactics has not been studied extensively, which means definitions and descriptions of the graphotactics of various writing systems are even sparser than works on other grapholinguistic problems (for an overview of graphotactic definitions, cf. Balestra 2017).

As implied above, just as there exist two broad types of allography, there are also two types of graphotactics. This is echoed in McCawley's (1994: 115) treatment of the subject in which he analyzes graphotactics on three different levels: "I will consider here three different kinds of units: letters, punctuation marks, and graphemic constituents of letters". The final level he lists broadly deals with the purely graphetic, visual restrictions for combinations of features within basic shapes, but also with combinations of individual basic shapes with each other. I will term this type *graphetic graphotactics*. The other type deals with the graphematic restrictions on combinations of graphematic units, i.e. restrictions that stem from the fact that writing represents language. I call this latter type *graphematic graphotactics*.

Graphetic graphotactics deals with the combinatory restrictions of visual material. A description of any writing system's graphetic graphotactics needs to start with an approach similar to Bredel's (2011: 19) or Jacobs's (2005). As already laid out above, Bredel decomposes the writing surface into three subspaces: the segmental space, the linear space, and the areal space (cf. Section 2.2.1.2). At a hierarchically higher level, I added to those the holistic space (cf. Meletis 2015: 115) which can be composed of various areal spaces such as paragraphs on a page, with the page being the holistic space. Considering my modification, the writing space is overall conceptualized as fourfold structured. All of these spaces are of relevance for graphetic graphotactics, although the segmental and linear spaces are clearly most crucial. What Bredel's (2011: 19-22) conception allows for is visually determining in which way classes of basic shapes – such as letters (or more generally, scriptual basic shapes), digits, special characters, and punctuation marks (cf. Section 2.2.1.2) – can combine to form larger units. In addition to these visible basic shapes, empty spaces also occur, which she treats as yet another class of 'graphic material'.[212] The empty space that occupies its own segmental space in German is used to visually separate graphematic words, the units treated in the section below. Bredel's focus is on explaining which punctuation marks occupy their own segmental space (*fillers*) and which cliticize on a different segment, thus do not occupy their own segmental space (*clitics*, for details see Section 2.2.2.5). Except for punctuation marks, all of the other types of basic shapes occupy their own segmental spaces. What Bredel's approach also shows is that other classes of basic shapes cannot combine randomly: digits can combine with each other to form larger units, in this case numbers, as in <911>, and letters can, of course, be combined with each other as in <house>. Punctuation marks, with exceptions such as <?!>, and special characters, cannot be concatenated to build larger units, and digits and letters cannot combine with each other quite so freely.

As stated above, this first type of graphotactics does not depend on linguistic, specifically graphematic information. This is true; nothing has been said yet about *how* different basic shapes – if they are indeed used graphematically – can combine within their classes, as the only thing discussed so far was the question of how the classes of basic shapes can combine with each other. Also, the basic shapes' individual graphematic function was not mentioned. However, I argue that these questions of how basic shapes of different classes behave within their classes and outside of their classes is also not solely graphetic, as knowledge about which basic shape belongs to which class is necessary, and as I have argued (cf. Section 2.2.1.2), this is not only graphetic knowledge. However, I admit that it is an open question whether the knowledge about a basic shape's assignment to a class is linguistic, metalinguistic, or not linguistic at all. It is most likely the second: knowing that a basic shape is a scriptual basic shape, a 'letter', for example, entails that one has at least a vague image of its function, as it is only knowing what its function is that allows assigning it to a class, but it does not entail that one knows what *exact* linguistic unit it represents or what its *exact* functions are.

As scripts are visual systems, there are rules of composition that determine what a well-formed basic shape is, whether this basic shape actually exists as a unit of a script or is only a hypothetical basic shape formed according to the features of the script (cf. Watt 1983a and Section 3.2.1). The creation of new basic shapes does not occur frequently, but sometimes, e.g. in Chinese, there is a need for a new basic shape. In this case, graphetic graphotactics become relevant. For Chinese, this includes knowledge about where subsegmental components (radicals and phonetics, cf. Section 2.2.2.1) can be placed within the segmental space with respect to each other. Not adhering to the graphetic graphotactics results in ill-formed basic shapes.

Graphematic graphotactics evaluates how the basic shapes can be combined within their respective classes. This corresponds with the common reading of the term *graphotactics*. At this level, it is actually not basic shapes that are central, but the graphemes they materialize. The

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[212] She does state, however, that it is yet unclear what semiotic status empty spaces have (cf. Bredel 2015).

licensed combinations and sequences of graphemes are to a large degree determined by how the linguistic units represented by the graphemes can be combined – but not completely. Günther (1988: 77) points out that the occurrence of <h> after <i> only in pronouns is a graphotactic constraint that is not determined by German phonotactics. This highlights not only at the material graphetic level, but also at the linguistic graphematic level, writing systems exhibit idiosyncrasies that can only be reasonably described and explained "intra-graphematically". Is this the case in every writing system? What is the reason for these idiosyncrasies? Graphotactics and phonotactics, or morphotactics for morphographic writing systems, drift apart considerably when the graphemes, i.e. the graphematic relations between basic shapes and linguistic units, are semiotically not transparent and uniform, which is the case in many writing systems. The less transparent or uniform graphematic relations are, the larger the graphematic solution space of a writing system becomes. This is not only where orthography comes into play, regulating which spellings are normatively correct (cf. Section 2.2.3), but also graphotactics: in fact, even before orthographic standardization kicks in, a writing system develops its own sets of combinatory rules to cope with the one-to-many relationship of basic shapes and linguistic units. The more biunique this relationship gets, however, the more redundant an autonomous graphotactics becomes: in Chinese, for example, where there is nearly a 1:1-relationship between basic shapes and morphemes, there are no graphotactic constraints for the combination of graphemes that *do not* result from the morphotactic constraints of morphemes that the graphemes represent.

2.2.2.4 Graphe(ma)tic word

In principle, what applied to the graphematic syllable also applies to the graphematic word. In the conception that this thesis follows, a unit that is defined solely visually should not be termed graphematic, but graphetic. Accordingly, in a first step, I will speak of the graphetic word. Secondly, a very central chicken-and-egg problem inherent to the analysis of writing comes to the forefront: the question whether the visual cues that allow a definition of the graphetic word are determined by other linguistic levels – such as morphology or syntax – or whether writing has independently developed this unit and it either influences other linguistic levels, e.g. by shaping our perception of what a 'word' is, or that it is completely independent of them. If the latter is the case, and the graphetic word is independent, this would make studying the correlations between it and other 'words' such as the morphological and the syntactic word a fruitful endeavor. As with the syllable, however, I argue for the former: word spacing developed to visually segment linguistic units (cf. Voeste 2008, 2016 for German), although the question remains whether this occurred primarily for structural reasons or reasons of processing (e.g. making silent reading more efficient, cf. Bredel 2011: 12f.; cf. Section 3.3.2.8).

This, then, leads to the central problem already encountered in the context of the graphe(ma)tic syllable: the graphetic word is not a universal unit. Spaces between words, too, even though they occur in many writing systems, are by no means universal, as a number of widely used writing systems – including Chinese, Japanese, and Thai – lack them.

What I set out to do in this section is to analyze which units are visualized by the second-order empty spaces that in many writing systems correlate with 'word spaces'. In order to do that, first, the concept of the graphematic word, established in German literature, will be presented, and then, as done with the graphematic syllable, carefully dissected in the context of a more universal perspective.

The seminal work for a definition of the graphematic word is Fuhrhop (2008). As in the context of the graphematic syllable, she cautiously states that "the term graphematic word is established here for German. Some aspects will be generalizable, others will not" (Fuhrhop 2008:

190, my translation).[213] The main criterion in defining the graphematic word are empty spaces: "The graphematic word stands between two spaces and does not contain any spaces internally" (Fuhrhop 2008: 193, my translation),[214] where 'spaces' means empty spaces. However, this completely graphetic definition is not fine-grained enough for Fuhrhop (2008: 194), who describes additional features of the '(proto)typical' graphematic word: 1) the typical graphematic word consists of one or more graphematic syllables (as defined above in Section 2.2.2.3), 2) the typical graphematic word is an unbroken sequence of graphemes, and 3) the typical graphematic word contains a maximum of one majuscule at the beginning of the word.

When the graphematic word is defined as everything between two empty spaces, this raises the question if punctuation marks, both sentence marks such as the period <.> and word marks such as the apostrophe <'>, which are mostly not separated from letters by spaces, are treated as parts of graphematic words. For the word marks, the apostrophe <'>, the divis <->, the slash </>,[215] and the period used after abbreviations <.>, the answer is yes. They are part of graphematic words (cf. Buchmann 2015; Evertz 2016: 392). By contrast, sentence marks such as the period used at the end of a sentence, as in <words.>, are not analyzed as parts of the graphematic word. Fuhrhop (2008: 217) explains this by arguing that <words.> is just a positional variant: if <words> were to appear sentence-internally, it could very well just be <words> or <words,>. As a sentence mark, the period <.> is enclitic to whatever graphematic word precedes it, whereas the period used after abbreviations as in <etc.> is an integral part of the word and occurs with it wherever the word appears within a sentence, with the exception of the sentence-final position, where the abbreviation period and the sentence period merge or one of them is deleted (cf. Bredel 2008: 28). Evertz (2016: 391) additionally argues that treating <words.>, <words?>, <words,> etc. as different graphematic words would greatly violate the principle of economy. He, like Fuhrhop, refers to Bredel's (2008) theory of clitics and fillers to explain that sentence marks are not part of graphematic words, whereas word marks are (cf. Section 2.2.2.5).

The graphematic word as defined above is a concept that poignantly proves that writing is not dependent on speech or, more precisely, phonology, but on language. In this vein, Fuhrhop & Peters (2013: 251) stress that the definition of the graphematic word differs greatly from the definition of the phonological word, which is often a much smaller unit. In fact, graphematic words frequently do not correspond with phonological words. By comparison, the morphological, but also the syntactic word are crucial in the makeup of the graphematic word (cf. Fuhrhop 2008; Evertz 2016: 394). However, even though these two types of words are mostly congruent with graphematic words (and with each other), there are exceptions: as Fuhrhop (2008: 225) states, if a graphematic word deviates from the canonical form of graphematic words, this is due to morphological and syntactic reasons. This is the case for German verbs whose morphological subcomponents can be separated within the sentence, such as <anfangen> 'to begin', where <an> can be separated from <fangen>, as in <Er fängt morgen an.> 'He starts tomorrow'. Syntactically, <fängt> and <an> are not separate words, whereas they are graphematically.

One of my earlier criticisms needs to be reevaluated at this point, namely that these kinds of analyses are not graphematic but instead graphetic. While it is true that what is written between two empty spaces can be determined visually, an analysis that determines that <words.> is not a graphematic word while <it's> is a graphematic word clearly transcends the boundaries of graphetics, as linguistic classifications become necessary, including the question

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[213] „Der Begriff des graphematischen Wortes wird hier am Deutschen erarbeitet. Einige Aspekte sollten verallgemeinerbar sein, andere werden es nicht sein."

[214] „Das graphematische Wort steht zwischen zwei Leerzeichen und enthält intern keine Leerzeichen."

[215] In later works (e.g. Fuhrhop & Peters 2013), the slash is omitted in the description of word marks because it can be verbalized (cf. also Section 2.2.2.5).

which of the punctuation marks are word marks and which are sentence marks. Thus, only the basis of the analysis is graphetic, while the fine-tuning is indeed graphematic.

This also means that the implication that there exist visually segmentable units in writing larger than the segment that can be defined solely graphetically, i.e. without recourse to other linguistic levels, is false: while for the graphematic word, no phonological information is necessary, a recourse to morphology and syntax is, characterizing the analysis not as graphetic, but as graphematic. Hence, we find that graphematic words largely overlap with a non-autonomous reading.

These overlaps, just like the overlaps of graphematic syllables and phonological syllables in German, are not accidental. In the light of these findings, one could ask how meaningful it is to propose autonomous graphematic units to then, in a next step, discover that they overlap with the written forms of linguistic units. Treating the linguistic units (in this case, morphological/syntactic words) as the basis and analyzing how they are written and only *then* treating the "deviations", i.e. features that are distinct to writing, could be a more economical strategy. However, it is a strategy which I also – in the context of the grapheme – categorically rejected, claiming the direction of analysis in grapholinguistics needs to be *writing → language*. Again, what this all boils down to is a methodological question, as proceeding one way or the other is really a methodological choice (cf. Eisenberg 2006; Schmidt 2016: 229f.), a choice the grapholinguist should be aware of and that has consequences. It is not a fixed choice, however: if one way is preferred for the grapheme or the graphematic syllable, the opposite direction can still be (and is) reasonable for the graphematic sentence, for example.

When considering second-order empty spaces in the writing systems of the world, it becomes evident that, synchronically, they are used to separate morphosyntactic words in all alphabets and abjads, but only in some abudigas and in no morphographic writing systems. In the systems in which the second-order empty spaces do not indicate words, they – sometimes in combination with punctuation, sometimes without it – indicate larger, syntactic units. An interesting question is whether – again, in analogy to the graphematic syllable as defined by Fuhrhop & Buchmann (2009) – there exist any other salient visual indicators than the empty space that make written units larger than the segmental grapheme visually discernable. The next question would be whether these visually defined units coincide with the word – the morphological, syntactic, or even phonological word.

In the Japanese writing system, in which the empty space next in size after the empty space between basic shapes indicates sentences, one very important cue for the segmentation of words is the alternation between the different scripts that are used. This alternation of scripts is not arbitrary, as they are used for different functions: morphographic *kanji* are used for lexical morphemes (nouns, verbs, adjective stems, some adverbs) and syllabographic *hiragana* for particles, auxiliary verbs, inflectional affixes of nouns, verbs, adjectives, and so on[216] (cf. Smith 1996: 209-212). Since most inflectional morphemes operate at the end of words, hiragana mostly mark this latter part of words. Consequently, the sequence hiragana-kanji usually marks the beginning of a new word, with the hiragana grapheme representing the end of the first word and the kanji grapheme the beginning of the next one. In this vein, some users of the writing system state that using only the kana syllable inventories (which is done in some contexts) obscures word boundaries and consequently hinders the detection of words during the reading process (cf. Section 3.3.2.8). As one user – a native speaker and reader/writer of Japanese – put it in a related thread on the Reddit sub *Learn Japanese*: "If you're reading in all hiragana/katakana, it's very hard to understand the word boundaries. (In kids [sic] books, they tend to put

216 And syllabographic *katakana* is used for even more functions: "to write foreign names and loanwords, onomatopoetic and mimetic words, exclamations, and some specialized scientific terminology" (Smith 1996: 212).

spaces) Once you learn more kanji/grammar patterns, the word boundaries become much clearer".[217]

The question is whether the visual cues given by this script alternation in Japanese can be compared to the [±length] feature that is prominent in Roman script and a number of other scripts. There, ascenders and descenders of basic shapes are visible even when the graphematic status of a basic shape has not yet been evaluated. In Japanese, however, it is not so much a visual cue as a graphematic cue: while the kanji predominantly look different than the basic shapes in the kana inventories, the visual difference is not straightforwardly and consistently attributable to the script, and it is questionable whether a kanji basic shape and a kana (e.g. hiragana) basic shape look more dissimilar than two kanji basic shapes or two hiragana basic shapes do script-internally. Thus, whereas in writing systems using Roman script, a line or a page can be skimmed without actually reading to perceive the long basic shapes and the less salient compact basic shapes, at least the ones at the extreme poles of the gradual length continuum, in Japanese, the alternation between scripts is not attributable to the fact that they appear visually different – rather, it is simply a matter of knowing which basic shape belongs to which script. It is a matter of classification. I am not going into details about whether this categorization is a graphetic or a graphematic matter, as one can know that a basic shape x belongs to script y without knowing what linguistic unit basic shape x represents exactly,[218] but I want to state at least that it is likely a more conscious process than simply perceiving which basic shapes are long or compact in relation to the hierarchical organization of the line.

In Chinese, where only the morphographic hanzi are used, words – whether morphological or syntactic – are not marked at all. It is a morphosyllabic writing system, which means that every grapheme, with only very few exceptions, represents a morpheme, and sometimes, these morphemes are what we would term 'words' or 'lexemes'. However, since most words in Chinese are polysyllabic (cf. Yen et al. 2012: 1009), frequently, they are just part of polymorphemic words or compounds, which is why the first-order empty space in Chinese does *not* commonly indicate words in a transparent manner. It indicates graphemes, which represent morphemes, by which it indirectly also indicates phonological syllables, but, as explained above, it does not consistently demarcate words. How words are still perceived and processed in Chinese and other systems lacking this type of empty spaces will be discussed in Section 3.3.2.8.

2.2.2.5 Graphe(ma)tic sentence and punctuation

With respect to one graphematic unit, the relationship of dependence between visual units and linguistic units is switched: for the definition of the graphematic sentence, seemingly no other underlying understanding of 'sentence' serves as a basis. As Schmidt (2016) argues, the opposite appears to be the case: the graphematic sentence is crucial for the colloquial as well as linguistic readings of 'sentence'. This situation is at least partially attributable to the fact that there exists no agreed syntactic (or other) definition of 'sentence'. Schmidt (2016: 217) gives an example from colloquial speech, where the request 'Speak in full sentences!' implies that language users have an internalized notion of 'sentence' (cf. also Dürscheid 2016: 57). In his attempt to give a formal description of the graphematic sentence, Schmidt (2016: 219) further points out that the existing definition is inherently circular: claiming that a graphematic sentence, and this is true for most alphabets, although he refers exclusively to German, starts with a sentence-initial majuscule and ends with a sentence mark is problematic as these criteria both require a pre-existing definition of the sentence. He then, as his predecessors have done, remarks about the importance of an intra-graphematic analysis. The difference is that while for

[217] https://www.reddit.com/r/LearnJapanese/comments/31u20m/getting_past_the_lack_of_spaces_between_words/cq4zd2v/ (January 24th, 2018); comment posted by user *mirukushake*.

[218] However, knowing which inventory a basic shape belongs to often automatically means knowing what *type of unit* it refers to, at least.

the syllable or the word, the relevance of this methodological choice was, arguably, greatly exaggerated, for the sentence, for the above-mentioned reasons, it appears justified.

In this vein, Schmidt (2016: 222) shows that, at least for German, the syntactic sentence and the graphematic sentence do not necessarily overlap, as the example <Olivenöle, zwei Regale voll.> 'Olive oils, two shelves full.' illustrates, which is 'smaller' than a syntactic sentence in that it lacks some of the features that a syntactic sentence must exhibit. Graphematic sentences, thus, can be both shorter or longer than sentences in the syntactic sense.

Schmidt (2016: 234) defines the graphematic sentence as a suprasegmental unit of writing, whereas, again, I prefer the term polysegmental, since written suprasegmentality in analogy to phonological suprasegmentality is already occupied by phenomena such as bold print or italics, where a visual feature actually *super*imposes the (poly-)segmental basis. Schmidt aptly illustrates that a reader does not need to know the linguistic values of the graphemes constituting a graphematic sentence in order to recognize it as such. Thus, in a structure such as <Xxx xxx xxxxxx. Xx xxxxx xxx Xxxx xxxx xx. Xxx, xxx Xxxxxx!>, three graphematic sentences can be visually discerned. It is at this point that, in line with my earlier remarks, I would question the adequacy of the designation *graphematic* sentence in relation to the alternative *graphetic* sentence. However, the empty spaces that separate graphe(ma)tic sentences from one another are not visually distinct from those that separate graphe(ma)tic words. The distinction must thus be made at a different level than the visual. Thus, for the time being, I adhere to the term *graphematic* sentence.

The two visual cues at hand are capitalization which opens and punctuation marks which end sentences. As pointed out above, for a graphematic definition of the graphematic sentence, these two criteria do not suffice. They cannot determine a graphematic sentence since they are simultaneously determined by the graphematic sentence. On a mere visual, graphetic level, they are also insufficient for a differentiation between the graphematic sentence and the graphematic word. At least in German, sentence-internal capitalization is not uncommon, and because of the ambiguity of the period <.> which can either serve as a word or a sentence mark, the middle sequence (printed bold) in <Xxx xxxx. **Xxx.** Xxxxx xxxx Xxxx xxx.> could either be a graphematic word (an abbreviation) or a graphematic sentence.[219] Graphotactically, it appears, the graphematic sentence cannot be defined in isolation. Thus, information that is necessary to recognize a graphematic sentence includes the end of the preceding structure and the beginning of the following structure. If there is a period preceding a capitalized word, there is a strong possibility that this instance of capitalization marks the beginning of a graphematic sentence. If any word of this sentence is followed by a period which in turn is followed by an empty space and a capitalized word, this possibly marks the end of the graphematic sentence. The graphotactic structure that Schmidt (2016: 234) arrives at is [.][][X][x$^{min/maj}$].

This structure can be verbalized as follows: a period followed by an empty space followed by a majuscule followed by either a majuscule or a minuscule. In unmarked cases, what follows the first majuscule is indeed a minuscule, except if a sentence starts with an acronym such as <EU> or a word that is written in all caps. The sentence-final period is a placeholder for all sentence marks that visually include a dot on the base line – this subsumes |!| and |?|, but also |:| (for a discussion of the colon in this position, see Schmidt 2016: 237-239). A more complex schema that allows for other, marginal cases as well (e.g. parentheses at the end or the

[219] Schmidt (2016: 242-246) discusses the problem of distinguishing the period used for abbreviations from the one used sentence-finally, referring to cases in which abbreviation periods behave exactly as sentence-final periods, e.g. the period after <a.> in <Robert Wiene u. a. Regisseure prägten den Expressionismus.> 'Robert Wiene and other directors shaped expressionism' (Schmidt 2016: 243). This is especially problematic for abbreviations that are well-formed graphematic syllables, Schmidt remarks, such as <sog.> (German abbreviation for *sogenannt*, 'so-called'). Following his analysis, the period in <sog.> would have to be interpreted as a sentence-final period. Finally, he admits, that this is where the 'inner-graphematic' analysis reaches its limits. Note that in Bredel's (2008, 2011) analysis (see below), too, a differentiation between the sentence period and the abbreviation period is not possible.

beginning of a sentence), is: [.\$^{fin}$][]**[^{ini}\X][x$^{min/maj}$]…[x][x][][x][x]…[.\$^{fin}$]**[][^{ini}\X][x$^{min/maj}$], where the part printed in bold represents a single graphematic sentence (cf. Schmidt 2016: 248). Here, \$^{ini}$ stands for an optional initial and \$^{fin}$ for an optional final cliticizing punctuation mark. Occurring initially are the opening parenthesis and an opening quotation mark, <(> <“>, occurring in final position are their closing counterparts, <)> <”>.

What follows from Schmidt's analysis is that both visually and functionally, punctuation is vital to the definition of the graphematic sentence. He highlights this by arguing that punctuation does not merely indicate sentences, it *constitutes* them (cf. Schmidt 2016: 215, 247). This, at last, seems to be, if not a universal, at least a universal tendency in the writing systems of the world. In every writing system, there is a second-order empty space, and in the ones in which it does not indicate words, it indicates sentences or syntactic units, almost always in combination with punctuation. Note, however, that Thai, one of the systems featured prominently in this thesis, has spacing between syntactic units – not only sentences but also clauses – while it lacks a period to mark the end of a sentence (cf. Danvivathana 1987: 262, 269). However, empty spaces are not only used between syntactic units, as there are additionally other orthographic conventions that require an empty space (such as 'Put a space between a person's military rank and their name', cf. Wathabunditkul 2003) that greatly complicate the picture.

Every alphabet in use today has empty spaces between words *and* sentences. Additionally, every alphabet has some sort of punctuation. A small set of punctuation marks – including the period <.> and the comma <,> – appear to be more universal than scripts, as they are used across a wide range of writing systems that otherwise use different scripts. In this context, a feature that needs to be mentioned that is *not* shared by all scripts used for alphabets is capitalization. Take Georgian, for example, which is a unicase script. Korean hangul, too, is a unicase script that is structurally alphabetical, but, possibly, functionally syllabic (cf. Section 2.3.2). Arabic and Hebrew, two abjad systems, also lack capitalization. However, both use punctuation and exhibit empty spaces between both words and sentences. For Thai, an abugida, the mixed Japanese system as well as the morphographic Chinese, capitalization is alien, too, but they all have punctuation, and spaces are used to mark units larger than words.

With her seminal works on the topic, Bredel (2008, 2011) changed the view of punctuation, at least the punctuation system of German, which is at the center of her analysis. In the context of generalizability, she explicitly remarks that a comparison of punctuation systems in different writing systems is a different task (cf. Bredel 2009: 118). The transfer of her ideas to the English punctuation system is the first step in that direction (cf. Kirchhoff & Primus 2016). Much in the vein of what has been stated for the graphematic units described above, Bredel supports an autonomous view of writing and consequently switches the perspective in which punctuation is commonly analyzed: while other conceptions see linguistic constructions or features thereof (sentences, questions, prosodic features etc.) as *inputs* for punctuation, Bredel interprets them as the opposite, as *outputs* of the reading process that is guided by punctuation marks. The first, traditional view is what Bredel terms the *offline*-view, while she calls the second view, the one she proposes, the *online*-view (cf. Bredel 2011: 5). Thus, the very core of her analysis of punctuation is that punctuation marks are treated as instructions for the reader that navigate the reading process. As such, they occur only if the reader has to deviate from the default-strategies of reading (cf. Bredel 2008: 18, 2009: 118).

Bredel's approach puts language processing front and center and differs significantly from older, more traditionally descriptive conceptions. Her analysis is notably not structuralist, but rather functional. One of the connotations that German punctuation has never quite lost is that it is (directly) connected to prosody. As a result, in the German tradition of punctuation description, the so-called 'rhythmic-intonational principle' (Baudusch 1976: 199) or 'rhetorical-intonational principle' (Kirchhoff 2017: 19-22) was always of some importance. At some point, however, the focus shifted away from intonation and onto syntax, the new consensus being that punctuation mainly functions to indicate syntactic units and relations (cf. Behrens 1989). This dualism underlines the two different functions associated with punctuation: indicating prosody and indicating syntax. Some descriptions of German punctuation outline a diachronic development away from the prosodic principle and towards the syntactic principle, implying that these principles are somehow mutually exclusive or that only one of them can be dominant while the other is only of relevance secondarily. In a description of many European punctuation systems (Dokumente 1939), the systems are also classified as either prosodic or syntactic, strengthening the view that there is a categorical division between the two. An additional, third aspect that is brought into the mix is stylistic freedom (cf. Nunberg, Briscoe & Huddleston 2002: 1727; Kirchhoff 2016: 399), which – not only pertaining to punctuation – I will mention in the discussion of *graphostylistics* (see Section 2.2.3). In a survey of these functions of punctuation, Kirchhoff (2016: 414) explains that the correlation between punctuation and prosodic features is not direct, but rather a consequence of the correlation between punctuation and syntactic features. It is, in turn, the close connection between syntax and prosody that creates the impression that punctuation is prosodic.

Without going too much into detail, a few more notable aspects of Bredel's game-changing analysis need to be mentioned. First, as Kirchhoff & Primus (2016: 94) note, in comparison to other conceptions, Bredel (2011: 9) operates with a *narrow* set of twelve punctuation marks: < . ; , : - – … ’ ? ! ( ) „ “ >. She arrives at this set through a graphotactic analysis that allows her to distinguish between basic shapes of the categories letter, digit, special character, punctuation mark, and empty space (cf. Section 2.2.1.2).

Bredel's most remarkable achievement for a theory of punctuation is the discovery of form-function correlations for punctuation marks similar to Primus's (2004, 2006) analysis of the basic shapes of Roman script. For the formal description of the inventory of punctuation marks, Bredel assumes three graphetic features: [±EMPTY], [±VERTICAL], and [±REDUPLICATED]. Whether a punctuation mark exhibits the feature [±EMPTY] depends on whether it has contact with the base line: < . ? ! : ; ( ) „ “ > are in contact with the base line and are thus [−EMPTY], while < - – … ‘ > do not touch the baseline and are [+EMPTY]. Here, it is notable that Bredel works with the historical forms of two punctuation marks to arrive at their feature value, namely the quotation marks < „ “ > that formerly were written as < ⟩ ⟨ > (opposite the parentheses that were written < ⟨ ⟩ >), and the ellipsis mark < … > that was formerly written as three strokes in the high subspace of the linear space < /// > (cf. Bredel 2009: 120). This also explains how she arrives at the feature values for [±VERTICAL], where the deciding criterion is whether a mark extends into the high space (or is solely located in the high space): < ? ! /// ’ ⟩ ⟨ ( ) > are [+VERTICAL], < - – : ; , . > are [−VERTICAL]. The final feature, [±REDUPLICATED], depends on whether the base element of a mark is visually reduplicated: < /// – ⟩ ⟨ ( ) : >[220] are [+REDUPLICATED], < - ; , . ? ! ’ > are [-REDUPLICATED].

Accordingly, three feature values can be assigned to every punctuation mark, which in turn allows the assumption of *graphetic feature classes* (cf. Bredel 2011: 4). The marks within these classes behave similarly with regards to function, cementing Bredel's hypothesis of form-function-correlations. The feature [±EMPTY] is of graphotactic relevance. Marks with the feature value [-EMPTY] such as the period <.> are characterized by the fact that their preceding and following 'neighbors' are never of the same class: what precedes the period is a letter (or a digit or a special character), what follows it is an empty space. Marks that are [+EMPTY], on the other hand, can be preceded and followed by basic shapes that are members of the same class, as in <geht's>, where the apostrophe is both preceded and followed by letters. Bredel (2009: 121) calls marks that are [−EMPTY] *clitics* since they cliticize on the unit that precedes them and, together with it, occupy only one segmental space. Marks that are [+EMPTY], on the other hand, are *fillers*, as they occupy their own segmental space.

Bredel (2011: 24) makes an observation that is crucial to the distinction between *graphetics* and *graphematics* and that is reflected in the difference between fillers and clitics. The pure

[220] Bredel (2008: 29), again reasoning historically, interprets the dash <–> as a reduplicated divis: <-->.

materiality of writing, she claims, makes visible certain linguistic units, such as words, but also larger units such as paragraphs, and graphetic elements such as columns can make visible at a glance even the genre of a text (cf. the concept of *graphetic dispositifs* in Section 2.2.1.2). These units, Bredel states, are constituted by the presence or absence of graphetic material as well as its organization in the writing space – they are *graphically coded.* As such, they are *scanned* and immediately perceived by the eye. In contrast, there are units that are not graphically coded as such. Graphetic material of different classes – the above-mentioned letters, digits, special characters – are combined and the larger units that they compose must be processed by the reader. These *linguistically coded* units are not perceived immediately, they must be *processed.* Based on this distinction, Bredel shows that fillers aid scanning, whereas clitics support processing. Roughly speaking, fillers aid physiology, clitics support cognition. The other features are also functionally relevant. [±REDUPLICATED] provides information about the scope of a punctuation mark: [−REDUPLICATED] has the word and the sentence as possible scopes, while [+REDUPLICATED] works on a textual level. At all of these levels, punctuation marks must be evaluated with regard to two aspects: a cognitive aspect (= parsing processes) and a communicative aspect (= which reader/writer roles are established through the marks?). Lastly, [±VERTICAL] informs about the exact function of each mark – for details (in German), see Bredel (2008, 2011).

As mentioned above, many writing systems share at least a subset of the punctuation marks treated in Bredel's analysis. These marks could have the same functions in these other systems – especially since 'instructing the reader' or 'guiding the reading process' as general functions of punctuation are certainly not language-specific.

2.2.3 Orthography

Let us turn to the last module of writing systems, the orthographic module. First, it must be noted that similar to *grapheme*, the term *orthography* is fraught with previous misuses, although in this case, the most prominent misuse is not a matter of controversial debate, but instead the accepted reading: in English, *orthography* is most often used descriptively, in the sense of *writing system.*[221] A search for English literature on orthography, thus, will yield as results predominantly descriptive works on writing systems that do not deal with the standardization of writing as a domain of language policy. This problem is also ostentatiously reflected in the practice of labelling the creation of writing systems 'orthography development' (cf. Lüpke 2011) instead of 'writing system development'.[222] In line with most German (grapho)linguists, I do not regard *orthography* and *writing system* as synonyms. Instead, orthography – as aptly illustrated by its etymology, see Greek *ορθός orthós* 'right, true (*also*: straight, erect)' – is to be understood as the standardization of a writing system (cf. Kohrt 1990: 116). It deals with the question of how to write (or spell) correctly with respect to external, explicit norms. Therefore, it is not to be conflated with the internal and implicit regularities that a writing system and its resources display – these are studied by graphematics (cf. Dürscheid 2016: 128) or, if they concern the visual resources of writing, graphetics. Also, as Neef (2015: 715) points out, orthography is not an obligatory, but an optional module of writing systems. Although many systems nowadays are equipped with this module, in theory, writing systems can do without it – and have done so in the past. This means that ontologically, the orthographic module developed (a lot) later than the graphematic module; as Sebba (2007: 33) notes, "the idea of a 'wrong'

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[221] Neef (2005: 8) remarks that in the English-speaking literature, this distinction between *orthography* vs. *writing system* is (especially in post-structuralist times) largely unknown.

[222] In these cases, however, one must admit that in the process of the creation of new writing systems, which commonly involves linguists, systems are consciously devised in a way that automatically minimizes the size of the graphematic solution space. Therefore, there might not be a big need for standardization. Since these systems are artificially created, the actors involved in the creation might not only have in mind *how to write*, but precisely *how to write correctly* – thus, from the outset, they truly have an orthography in mind and not an unstandardized writing system without orthography.

spelling is only two centuries or so old”. Ironically, however, in literate communities in which there exists an orthography, it is, in contrast to writing systems, phenomenologically primary (cf. Schmidt 2018: 34). As Schmidt (2018: 34f.) argues, a writing system is not the underlying basis of an orthography – rather, the writing system is located *within* the orthography, and even linguists frequently deal with writing systems only through orthographies. Schmidt argues that in a literate community such as Germany, children do not just learn to write, they learn to write *correctly*. Writing, as a cultural practice, is intricately and inseparably linked to normativity.

The reason that *orthography* took over as a general descriptive term is that it is not straightforwardly clear where to draw the line between graphematics and orthography. Its misuse, thus, is partially understandable; however, that does not make it tenable. As described above, graphematics deals with the relations, correspondences, and regularities between visual units and linguistic units. A writing system offers its users certain resources and possibilities which they can in principle all use to compose written utterances. The fact that there is seldom a one-to-one-correspondence of basic shapes and linguistic units (or, more generally, visual resources and linguistic functions) in writing systems is reflected in the existence of the above-mentioned graphematic solution space. It is the possibilities and the variation therein that call for standardization.

The main (though not the sole) function of graphematics is to allow writers to compose messages that can be read – deciphered and understood – by potential addressees (which, in cases like shopping lists, include themselves). One could term this function *(auto-)communicative* in that it makes possible communication. However, a given linguistic element, e.g. a word, cannot be written randomly, as there are limits to the graphematic module. A spelling, thus, cannot violate too many graphematic relations in order to still be understandable: the word ‘write’ could, in theory, be spelled ‘ryte’ or ‘right’,[223] but not ‘groeqx’. It is the function of orthography to oblige the writer to obey the prescriptive rules that a community of writers has – more or less bindingly – agreed on by singling out one (or multiple) possible spelling(s) as the correct one(s) (cf. Karg 2015: 5). Its function is *conventionalizing* and *standardizing*.

While this might clarify what an orthography is, it leaves open the question of how it diverges from graphematics in systems that have an orthographic module. To answer this, the relations between system, norm, and use need to be examined. As illustrated in Figure 19, these three realms overlap significantly but also display some distinct areas.

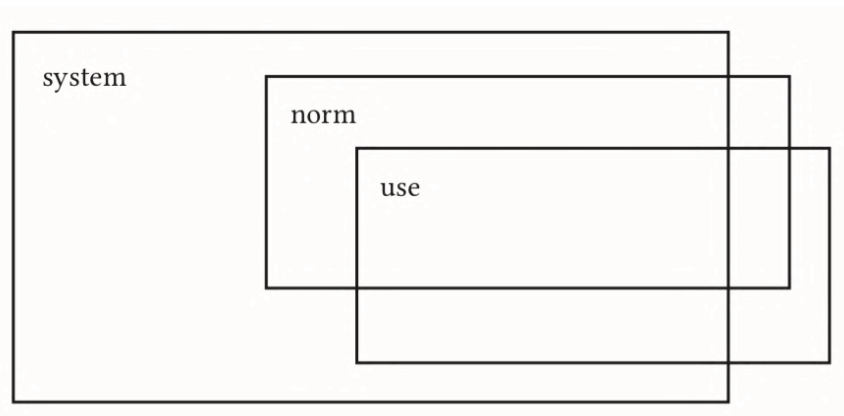

Figure 19: Trichotomy system-norm-use, from Mesch & Noack (2016: 4)

A system, of course, must first arise – whether through a ‘natural’ process as in the independent creation of the Chinese, Mayan, and Sumerian writing systems or through the process of adopting a type of writing system, which is the common way writing systems are devised now-

[223] This specific spelling would lead to the same phonological representation, but a different meaning as it is used for a different word.

adays.[224] Once established, writing systems are characterized by the fact that they are used. On the one hand, this use both constitutes the system and draws on it – it is the "sum of the relatively synchronized internal norms of the writers of a language" (Schmidt 2018: 36, my translation).[225] On the other hand, the use of a system simultaneously deviates from it: spellings that are not 'systematic', i.e. that do not follow from the regularities of the system, are initially perceived as deviations. Here, one must carefully separate conscious deviations – e.g. for reasons of style, creativity, innovation, or simply because of the rejection of the current norm[226] – from unconscious deviations – mistakes or errors. These deviations from the system, however, are much rarer than deviations from the norm (see below).

In the long term, these deviations can instigate a change of the system and become part of the system – this, in a nutshell, is one way in which the graphematic module (and languages as wholes) can change. Another factor that must be taken into consideration – one much stronger in the modality of writing than in speech – is standardization, or the norm(s). Ideally, only spellings that are part of the system should be part of the norm – in the instances in which this is the case, Neef (2015) speaks of *systematic orthography*. However, spellings that are designated as orthographically can sometimes not be reconstructed by means of the regularities of the graphematic module, meaning they are excluded from the graphematic solution space. They might still be present in actual usage, which (see above) does not always conform to the system, but – in extreme cases – they might neither be part of the system nor present in usage. But just as use can change the system, norms can change it, too: a norm that might initially be unsystematic can come into (increasing) use since users are influenced by normativity and can thereby also lead to a change of the system. Diachronic change of writing systems can, therefore, only be understood and explained through this triad of system, use, and norm (cf. Mesch & Noack 2016: 4).

This helps to separate graphematics from orthography: graphematics deals with system and use, while orthography is concerned with the norm. Whereas orthographic rules are explicit and externally codified, graphematic 'rules' are implicit and internal and manifest themselves only in the use of the system (cf. Fuhrhop & Peters 2013: 186). However, these two types of norms are intricately related to one another: the primary internal norms that are derived from the use of the system can be externalized to become codified norms, and vice versa, external norms can be internalized (cf. Berg 2016a: 19).[227] As Schmidt (2018: 29) notes, institutionalized literacy instruction in schools and the orthography that is taught there influences the internal norms of the writers, and consequently, this affects the use and with it the writing system, which he defines as the sum of empirical regularities. Thus, orthography is primary and greatly influences the writing system and its graphematics. A critical problem that arises in this context is that in the analysis of written texts, i.e. products of the use of the system, it is not possible to tell internal rules and external rules apart, as the text does not reveal which of them the writer followed (cf. Kohrt 1987: 341). However, Berg (2016a: 20) describes an interesting exception: if there is a deviation from the external norm in usage, and this deviation displays

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224 One could argue that it is the only way of creating writing systems nowadays, as these 'natural' independent creations of writing systems worked only because the cultures in which they occured did not know about writing. Of course, it is not impossible that there exist cultures today that do not have knowledge about the *existence* of writing.

225 „[...] Menge der relativ miteinander synchronisierten internen Normen der Schreiber einer Sprache."

226 There are still people in the German-speaking area that do not conform to the reformed orthography of 1996/2006. Among them are university professors, some of which have even studied orthography (examples are Utz Maas, Theodor Ickler). Here, the deviance from the new standard is not to be regarded as an error or a mistake, but as an intentional choice – and a form of sociolinguistic action.

227 Kohrt (1990: 118) goes farther and claims that external norms not only *can* be internalized but that an internalization is actually demanded.

some sort of systematics, then an internal rule has to be responsible.[228] In that case, the deviation from an external norm is not due to errors in performance, but due to a different underlying competence system. This means that a writer has an idiolectal writing system with its own regularities that neither conforms to the actual, inter-individual graphematic system nor its standardization, its orthography.

Nerius (2007) lists four crucial features of an orthography: as already mentioned, it is an (1) external, codified norm. It is characterized by its (2) bindingness, a (3) small degree of variability, and, even though it is in principle static in nature, its (4) possible changeability. In what follows, I will discuss each of these features in detail.

An orthography is an (1) *externally codified standardization*. This means that orthographic rules are codified either in a set of regulations, or in a dictionary, or – commonly – in both. As we will see below, orthography is a central aspect of language policy. As such, it is regulated by certain institutions that are linguistically authoritative. For example, for the pluricentric German-speaking region, this is the *Rat für deutsche Rechtschreibung* (Council for German Orthography);[229] in Japan, it is the *bunka-chō* (文化庁, Agency for Cultural Affairs),[230] a part of the Ministry of Education, Culture, Sports, Science and Technology; in Thailand, it is the *Ratchabandittayasapha* (ราชบัณฑิตยสภา, Royal Society of Thailand);[231] in South Korea, it is the *Gungnip Gugeowon* (국립국어원, National Institute of Korean Language),[232] and so on. Sometimes – as is the case in Thailand – the same regulator publishes the set of orthographic regulations as well as a prescriptive dictionary (in this case the *Royal Institute Dictionary*), meaning the double codification of orthography is attended to by the same agent. However, even when these two tasks are separated, there is a tendency for them to overlap. For example, the *Duden*, who publishes the most influential dictionary of German, designates 'preferred spellings' in cases in which there are two or more variants deemed correct by the Council for German Orthography. In the case of <ph> vs. <f> in words such as <Typografie> 'typography', the Duden explicitly favors the variants with <f>, with some exceptions[233] (cf. Duden 2017: 15). This adds a level of complexity, as orthographically licensed variation is further subjected to – even if only non-binding – regulation.

A second and very prominent feature of an orthography is its (2) *bindingness*. While an orthography is not legally binding, meaning there are no legal ramifications when individuals do not adhere to it, it is socially binding in that literate linguistic communities accept and value its legitimacy and expect its members to adhere to its rules. This means that while deviations are not legally penalized, they are socially sanctioned in various ways (cf. Nerius 2007: 36f.). This shift of focus from the system and its regularities to the norm and its rules has been adamantly criticized, for example by Maas (2015) (see also Eisenberg 2017). Maas aptly demonstrates the problematics of this focus by deconstructing a German word for orthography (and a quasi-synonym of German *Orthographie*), *Rechtschreibung*. While the second part *-schreibung* amounts to 'spelling' (albeit without any normative connotations that the English 'spelling' might already include), the meaning of the first part, *Recht*, is commonly associated with the word *richtig* 'correct' instead of *Richtung* 'direction', and *recht* as in *es jemandem recht machen* 'to please someone'. Maas (2015: 3) claims that it is indeed the latter two meanings that contribute to *Rechtschreibung*, and, thus, the primary function of an orthography should not be to determine what is correct and sanction what is incorrect but instead to act as a guideline of

[228] Cf. in the German original: „Wenn die externe Norm sich nicht im Usus wiederspiegelt [sic], dieser Usus aber gleichzeitig eine gewisse Systematik hat […] – dann muss eine abweichende interne Norm dafür verantwortlich sein" (Berg 2016a: 20).

[229] Cf. http://www.rechtschreibrat.com/ (December 12th, 2017).

[230] Cf. http://www.bunka.go.jp/english/index.html (December 12th, 2017).

[231] Cf. http://www.royin.go.th/ (December 12th, 2017).

[232] Cf. https://www.korean.go.kr/front_eng/main.do (December 12th, 2017).

[233] Some spellings remain exceptions, most of them loandwords such as <Graph> 'graph', <Graphem> 'grapheme', <Phonologie> 'phonology', and <Phantom> 'phantom' (cf. Duden 2017: 15).

how to write reasonably. The central maxim should, therefore, not read 'write by the rules', but 'write how you want to be read'.[234] What is criticized here is exactly what has been alluded to above: system and norm have converged to such a large degree that *to write* has increasingly become equated with *to write correctly* with little to no tolerance for deviations (cf. Nerius 2007: 36; Schmidt 2018: 35).

Two additional points need to be mentioned. Firstly, it is interesting to note that this high level of awareness for norms and rules that accompanies writing is not characteristic of speech. *Orthoepy* is not only a seldom-used term for 'speaking (or pronouncing) correctly' (cf. Pabst-Weinschenk 2016), but the concept associated with it is to a much lesser degree important in a literate linguistic community than orthography. This, Nerius (2007: 37) claims, is due to the different features of speech and writing, the most important being that prototypically, speech is transient and writing is permanent. Deviance from the norm is thus often missed in (non-recorded) speech while non-standard-spellings are commonly visible and traceable long after they have been produced. Another aspect in which this difference between speech and writing shows is the use of dialect. Dialectal speech is much more common than dialectal writing. While the former also frequently comes with connotations and is associated with different social categories, it is also often seen as part of an individual's (linguistic) identity (cf. Milroy 1982). It is thus not so much perceived as a deviation from a norm, but as a social (regional, etc.) marker. In writing, the use of dialect appears much more restricted. Dialectal writing does occur in informal contexts (such as instant messaging), in prose, and poetry, among other occasions. However, with regard to one function that is commonly assigned to writing – fixing the supraregional standard variety of a given language –, dialect is often more strongly marked in writing that it is in speech.

Secondly, what contributes to the bindingness of orthography are the expectations that its users have of it: they expect the codified norm to tell them exactly what is deemed 'correct', which is also the motivation for the above-mentioned recommended spellings of the Duden in cases in which more than one variant is correct. The average user does not want to have the choice; they rather prefer a clear rule they can obey (cf. Nerius 2007: 37; Sebba 2009: 44).

Sebba (2007) has studied orthography as social practice and offered a framework for categorizing and understanding deviations from the norm that function only precisely because the norm is perceived as binding. He establishes that orthography or non-orthography, i.e. deviance from the norms, can only work if the writing system allows for variants, i.e. if the graphematic solution space is large enough for there to even be a need for an orthography. If there is variation, it can be *licensed* (see below) in that "the conventional norms allow for a choice" (Sebba 2007: 30), or it is *unlicensed*, in that the norms are disobeyed; however, this has to happen in a way that "allows the original meaning to be conveyed, along with additional social meaning which derives from defying the conventions" (Sebba 2007: 30). This means that even unlicensed variation is restricted by conventionality, as unlicensed forms still have "to be close enough to the norm to be recognisable to other members of the language community" (Sebba 2007: 32). If they were not, they would either not fulfill their communicative function or convey the layer of additional social meaning intended by the process of breaking the rules – or both. Accordingly, deviant spellings are "not necessarily unsystematic" (Sebba 2007: 46). This corresponds with what has been established above: spellings can be outside orthography but still inside the regularities and rules of the writing system. The potential for orthography to serve as social action resides inside the so-called "zone of social meaning" (Sebba 2007: 34), which is necessarily located outside of the orthographic module[235] and works only on the basis of the fact that "choices are made in particular social, historical and cultural contexts" (Sebba

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[234] „Gebildet ist das Wort [Rechtschreibung, D.M.] mit dem Ausdruck für *Richtung*: als Vorgabe, wie sinnvoll zu schreiben ist. […] Der Ausgangspunkt dafür läßt sich als grundlegende Maxime formulieren: *schreib, wie du gelesen werden willst*" (Maas 2015: 3, emphasis in original).

[235] However, it must be noted that adhering to the orthographic norms is *also* a choice and therefore also carries social meaning.

2007: 26). Lastly, when it comes to freedom to deviate and associated sanctions, Sebba (2007: 43f.) assumes a number of regulated spaces that differ in how strictly they are regulated; the boundaries between them are fuzzy (cf. Figure 20). In *fully regulated spaces* (such as schools, publishing houses, etc.), which are located at the center of the orthographic space, deviations from orthography are strictly sanctioned, while in *partially regulated spaces*, acceptance for breaking the rules is higher. Finally, there are *unregulated spaces* in which acceptance for unlicensed variation is high.

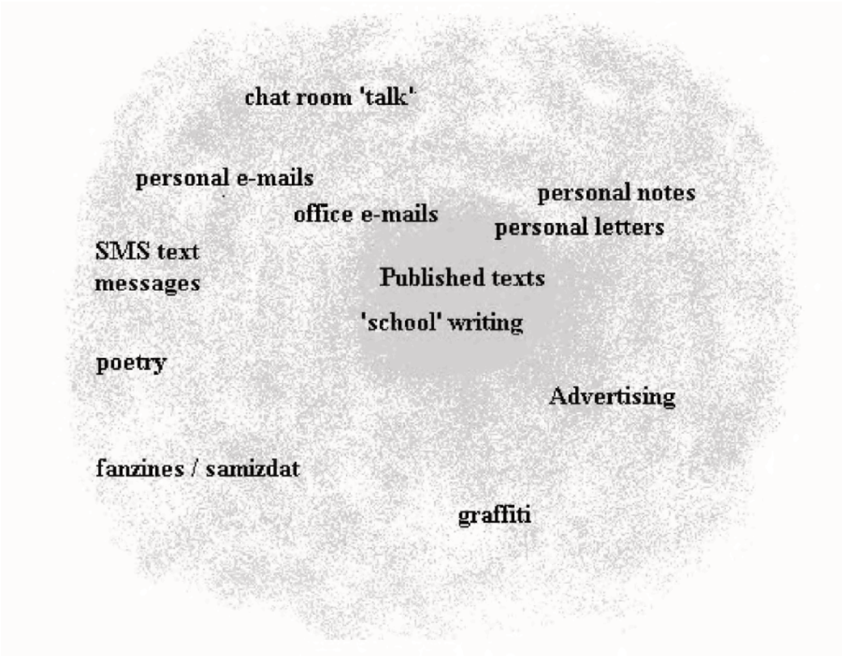

Figure 20: Orthographic space, from: Sebba (2007: 43)

Following up to what has been just said, what generally characterizes orthographies is the (3) *small degree of variability*. Even if the graphematic solution space of a given writing system is fairly large, orthographically licensed variation is commonly kept to a minimum. This is intricately linked to the just mentioned expectations of an orthography's users, the majority of which (though certainly not all) do not want to have the responsibility to choose from variants. What an orthography effectively does – and this is at the core of the major criticisms brought up against it, cf. Maas (2015) – is restrict the resources at the disposal of the users of a writing system, thereby depriving them of the possibility to choose. It hinges on the perspective, then, if one interprets orthography as a useful regulation, preventing the possible 'chaos' that would ensue if writing was not standardized, or instead as a restriction, curtailing the linguistic freedom of scribes. It seems as if usually, the communicative function of orthography is deemed much more important than any creative freedom that might be restricted by an orthography. To be communicatively successful, one must be understood, and unambiguously correct, codified spellings seem to be interpreted as an instrument to achieve exactly that. Variants, on the other hand, would be perceived as inexpedient and disruptive, even if they did not interfere with the understandability of a written utterance (cf. Nerius 2007: 39).[236] Understandability, thus, fades into the background, while the striving for uniformity through conformity to the norm comes to the forefront.

[236] „[…] angesichts der Tatsache, dass der gedachte Kommunikationspartner hierbei [beim Lesen, D. M.] für die Erfassung der Äußerung einzig und allein auf die ihm vorliegende graphische Form angewiesen ist, wird es im Interesse einer eindeutigen und raschen Informationsentnahme offensichtlich als unzweckmäßig und störend angesehen, wenn die Schreibung eine Vielzahl von Varianten enthält, selbst wenn solche Varianten das Verständnis des Textes keineswegs grundsätzlich behindern" (Nerius 2007: 39).

One area in which the small variability of an orthography does seem to filter through is the (gradual) integration of foreign material, which, as we will see below, is a crucial task that any orthography – regardless of which (type of) writing system it regulates – has to take on. An older survey of German dictionaries shows that less than 1 % of word spellings in a dictionary display licensed variation, and here, 80 % concern the spelling of loan words (cf. Gabler 1983). The question of how variable typologically different orthographies can be will be discussed in greater detail below.

The last prominent feature Nerius (2007: 39f.) lists is (4) *changeability*. The changeability of an orthography stands in stark contrast to the changeability of writing systems. A writing system, as described above, is rather dynamic in that through usage, it can change. It can, for example, expand when unsystematic forms become systematic. The interrelations between system and use are lively and natural in that they are not regulated by norms – at least not external, codified norms. The specifics of an orthography, on the other hand, make it static. It cannot react to the actual use the same way that the system can, since changes of the norm can only be achieved through changing the codification. This is not a task undertaken by the language users themselves, but a matter of language policy attended to by the above-mentioned regulators, institutions of authority. Changes of the norm can be achieved exclusively through orthographic reforms, which are not only driven linguistically, but (one might argue predominantly) politically (for the German orthography reform(s), cf. Schimmel-Fijalkowytsch 2018). Nerius (2007: 40) notes, however, that not every little change of the codification can automatically be regarded as a full-fledged reform, a term that is appropriate only when general rules, that is rules that are generalizable over numerous contexts, are affected by the change. If only isolated cases – single spellings, for example – are changed, these minor modifications do not constitute a reform. However, in any – even the most minor – case, the codification has to be changed. Instead of calling an orthography static, one could also say it is stable. The fact that norms, or more precisely, rule explications, make it possible to consult the correct spelling contributes greatly to this stability (cf. Kohrt 1990: 116).

The most central linguistic phenomenon that needs to be discussed with respect to orthography is the concept of *rule*. Unlike the descriptive rules (to be read as 'regularities') of other linguistic domains – such as syntax, morphology, phonology, but also graphematics – orthographic rules are of prescriptive nature. They are to be interpreted as instructions to produce spellings that conform to the norm (cf. Ewald 2007: 43). Firstly, and crucially, I want to explicitly note the conceptual difference between rules and explications of rules. As Kohrt (1990: 108, my translation) already noted, "the same entity can never be part of a linguistic norm and simultaneously serve as the description of that exact norm".[237] Object level and metalevel must not be conflated. To distinguish between these two phenomena, in this thesis, the first one is referred to as *rule* (or *norm*) while the second is termed *rule explication* (or *norm explication*).

There are several subtypes of orthographic rules that must be distinguished: Firstly, one must separate *given rules* from *set rules*. The difference between them can be explained by looking at the aforementioned relationship between the system and the norm. *Given rules* correspond with graphematic rules or regularities – they represent rules that have arisen naturally in the use of the system. This can be explained by reference to invisible-hand-theory (cf. Keller 2014): language users, in this case acting as scribes, have implicitly agreed on conventions that consequently have the potential to develop to rules. The term *given*, thus, underlines that these rules are already *given* in the system, and the norm explication merely codifies them. Ewald (2007: 42) argues that when given rules are codified, they are externalized and, thus, also become *set rules* (see below). This is, of course, true, but I think it is terminologically more elegant to still speak of *given rules*, highlighting the fact that they are codified orthographic rules that are nonetheless based in the system and its use. This type of rules corresponds with what Neef

[237] „Ein und dieselbe Entität kann niemals Bestandteil einer sprachlichen Norm selbst sein und zugleich der Darstellung eben dieser Norm dienen!" (Kohrt 1990: 108).

(2015) labels *systematic orthography*. After these *given rules* have been transferred from graphematics to orthography, their filtering application to the graphematic solution space might still offer more than one possible candidate for a orthographically correct spelling. In this case, "[c]onventional orthography […] decides which of these options the correct one is" (Neef 2015: 720). Because all of the options that *conventional orthography* may choose from are systematic in that they obey the given rules, the choice between them is either arbitrary or determined by another type of rules, *set rules*.

Set rules are rules that only exist in their externalized form; they are rules that "are dependent on a metalinguistic objectification and only function because of being explicitly recorded" (Ewald 2007: 42, my translation).[238] In other words, they are rules that are dependent on their rule explication; and even more than that: they are *constituted* by their rule explication. Unlike given rules, they are commonly obeyed consciously. In Figure 19 above, these rules fall, at least after their inception, into that part of the norm that does not overlap with the system. They can, however, also be positioned in the overlap with the use in cases in which the norm reacts to the use and codifies unsystematic but nonetheless occurring spellings. However, it is also possible that set rules fall into the realm in which the norm overlaps neither with the system nor the use. This latter situation arises when regulators – with different motivations – construct and codify spellings that are not yet in use and are not systematic. In a case in which a spelling is codified as orthographically correct even though it is not part of the graphematic solution space, I would speak of *unsystematic orthography* as the opposite of *systematic orthography*. Unlike systematic orthography, unsystematic orthography is always simultaneously conventional. This also explains why Neef (2015: 720) posits that "conventional orthography cannot be fully reconstructed as a theoretical system, but only partially". The systematic part can be reconstructed, while the unsystematic part cannot.

In the history of German orthography, for example, spellings of loan words have been codified that were not motivated by real use. However, as the Council for German Orthography had to realize that even after codification, they never came into use, some were dropped again from dictionaries. In its 27th edition, the Duden reacted to the 2016 report of the Council and dropped spellings such as <Ketschup> 'ketchup', <Joga> 'yoga', <Grislibär> 'grizzly bear', and <Majonäse> 'mayonnaise' because they are not in use (anymore) (cf. Duden 2017: 18).

An analysis of the scope of rules leads to three more categories: *principles*, *general rules*, and *singular rules*. The term *principle* is very prominent in the German-speaking literature on orthography, but it is not unproblematic as it also contributes to blurring the line between graphematics (and thus, system and use) and orthography (norm). In lists of principles one can commonly find the phonological (also termed phonetic, phonographic), syllabic, morphological, economic, lexicosemantic, etymological, aesthetic, grammatical, textual, and pragmatic principles, among others (cf. Karg 2015: 48-69). Following Rahnenführer (1989), *principles of writing*, which are graphematic in nature, need to be kept apart from *principles of orthography*, which are orthographic. Here, admittedly, a neat separation of graphematics and orthography really poses a challenging task. When Kohrt (1990: 112, my translation) speaks generally of 'principles', for example, it is unclear which of the two he refers to:

> […] principles, which are essentially valid cross-linguistically and which have, in particular contexts, and more or less strongly, prevailed in different stages of the development of a language in what was effectively a 'free play of forces.'[239]

[238] „[…] sind also an ihre metasprachliche Objektivierung gebunden und funktionieren nur dank ihrer expliziten Aufzeichnung" (Ewald 2007: 42).

[239] „[…] ‚Prinzipien', die grundsätzlich einzelsprachübergreifend sind und sich in den verschiedenen Stadien der Entwicklung einer Sprache in einem quasi ‚freien Spiel der Kräfte' an einzelnen Stellen jeweils mehr oder minder stark durchsetzen".

Somewhere else, he writes that principles are

> essentially an expression of an *a posteriori systematization* of what language users participating in writing in alphabetic writing systems have done, and use of [the term 'principle'] rests basically on the mere *insinuation* of action-driving maxims that determine the doings of individuals in a given practical area. (Kohrt 1987: 516, my translation)[240]

I argue that what Kohrt describes are *principles of writing*, i.e. possibilities of encoding different features/aspects of linguistic elements – sound and meaning – in various ways. This already anticipates the discussion of what is natural in writing and which naturalness parameters are in conflict with each other – a situation Kohrt refers to as a 'play of forces'. If a scribe can choose to write the derived noun of German <kalt> 'cold' either <Kälte> or <Kelte>, he or she has to decide what is more important to him or her: phonographic transparency (the phonological/phonetic/phonographic etc. principle) and with it a basic shape-phoneme-correspondence that is closer to biuniqueness or morphographic transparency (the morphological principle), sacrificing the one-basic shape-one-phoneme ideal in the process. Thus, he or she can choose from resources the graphematic module of a writing system offers. At this point, no orthographic norms or rules are intervening. However, these general principles of writing can be operationalized and transferred to a normative context. This is what Kohrt means when he speaks of an *a posteriori systematization*: Orthographies, at least in their initial stages, draw heavily from the system and its use, and on the highest level of abstraction, this concerns the general possibilities of a given writing system to refer to the different levels of language – phonology, morphology, lexicon, etc., later including also possibilities that are not necessarily driven by linguistic reasons, cf. the aesthetic or the pragmatic principles. After having been transferred from the system to the norm, these principles of writing indeed become *orthographic principles* that now serve as 'action-driving maxims' and can fruitfully be instrumentalized by language regulators as a template in the design of new rules. This is also the reason it is so hard to draw a line between principles of writing and orthographic principles: they overlap greatly. But principles of writing are ontogenetically primary and the secondary orthographic principles can only work with what the principles of writing are offering. For this reason, the very general orthographic principles cannot be changed the same way orthographic rules can be changed (cf. Rahnenführer 1989: 291). They are not without normative force, but they are not as normative as rules as they lack the nature of instructions (cf. Naumann 1990: 149; Rahnenführer 1989: 290). Instead, they act more as an orientation, which is why the term *orthographic orientation* has also been suggested for them (cf. Kohrt 1987: 509f.). Because they offer some normative 'guidance' and serve as the basis for general rules, they are sometimes also referred to as rules of a higher order, so-called *hyperrules* (cf. Kohrt 1990: 106).

To settle another matter, I want to comment on the cross-linguistic applicability of principles of writing and orthographic principles, respectively. The former, as described above, represent general possibilities of how a writing system can refer to different levels of language. These principles are not specific to a given writing system, but, I would argue, to a type of writing system, something Kohrt implied by singling out 'alphabetic writing systems' (probably vs. other types of systems). It is the general nature of possible graphematic relations in a system (the smallest one of which is the grapheme) which determine which linguistic levels can be referred to by a writing system. Thus, the principles in fact represent the possibilities of a type of writing systems in that they are not specific to individual systems but also cannot be generalized across types. In fact, in this light, what types of writing systems are is an *a priori* prioritization of one principle that leads to a categorical and terminological distinction: phonographic writing systems rely heavily on the phonological principle (and related principles such as the

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240 Der Begriff *Prinzip* ist „wesentlich Ausdruck einer *nachträglichen Systematisierung* dessen, was die Sprachteilhaber am Schreiben mittels Alphabetschrift getan haben, und seine Verwendung beruht im Grunde auf einer bloßen *Unterstellung* von handlungsleitenden Maximen, die das Tun der Individuen in einem bestimmten praktischen Bereich bestimmen" (emphasis in original).

syllabic principle), while morphographic writing systems naturally rely on the morphological principle.

Unlike Rahnenführer (1989: 288), I do not believe that the orthographic principles which derive from principles of writing are specific to given languages and their writing systems. Of course, relevance and relative hierarchical ordering of orthographic principles can differ even in orthographies of writing systems of the same type: some alphabetic orthographies, for example, choose to favor the phonological principle (Finnish, for example), while other orthographies emphasize the morphological or etymological principle (like English). The repertoire of principles of writing that orthographies can draw on, however, is the same, which means that the very general orthographic principles are not inherently writing system-specific. What is indeed writing system-specific is *orthographic rules* for which the orthographic principles, as hyperrules, serve as a basis.

Regarding orthographic rules, a further distinction must be made between *general rules* and *singular rules*. In a nutshell, general rules affect not only single spellings, but groups of spellings, whereas the scope of singular rules is limited and contains only isolated cases (cf. Ewald 2007: 44-48). This means that general rules, as subrules of orthographic principles, have a larger scope and apply to a more general context, while singular rules work in the most minimal context: a single word, or maximally a few words. Traditionally, one would call singular rules *exceptions*, precisely because they cannot be subsumed under a general rule – or because they contradict a general rule, which is the case when in a given context in which a general rule usually applies, it does not. An example for a general rule explication is the codification of the use of <ß> in some varieties of German: when /s/ occurs after a long vowel or a diphthong and is not followed by a consonant in the stem of the word, <ß> is generally written (cf. Amtliche Regelung 2018: 29, § 25; Ewald 2007: 45). This general rule explication states a context and gives instructions on what must be done in that context. Singular rules are of relevance especially in contexts in which we find so-called 'false' general rule explications, such as rule § 18 in the codification of German orthography: "in a few words, the diphthong [aɪ], as an exception, is spelled <ai>"[241] (Amtliche Regelung 2018: 24, § 18, my translation), with an addendum stating "this concerns words such as Hai ['shark', D.M.], Kaiser ['emperor', D.M.], Mai ['May', D.M.]". Because the list of words exceptionally spelled with <ai> is not exhaustive, this supposedly 'general' rule including its addendum does not suffice to spell /ai/ correctly in all contexts (cf. Gallmann & Sitta 1997: 95). This is exactly where singular rules are needed: in order to know how to correctly spell words containing /ai/ that are not already given in this short list of examples, a writer must look it up in a dictionary.

This leads us back to the *double codification* of orthography: general rule explications such as the <ß>-rule above are codified in sets of orthographic rules. Singular rule explications, on the other hand, are codified in (orthographic)[242] dictionaries, with every entry representing a singular rule explication. Initially, orthographic dictionaries resembled appendices in that they offered illustrative examples of the rules that were laid out in the sets of orthographic rules, demonstrating how the rules were to be applied in practice (cf. Schaeder 1986: 199). Kohrt (1990: 110) observes that there is an inverse relation between the public interest and the theoretical interest in dictionaries: while it is often a matter of public debate which words were newly 'added' to (and, thus, codified in) dictionaries, which spellings have changed, etc.,

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[241] „In wenigen Wörtern schreibt man den Diphthong [aɪ] ausnahmsweise *ai*."

[242] Kohrt (1990: 119) comments on the fact that lexicographers usually – with very few exceptions – use orthographically correct lemmas in all kinds of dictionaries: this, according to him, makes it difficult to distinguish true 'orthographic' dictionaries from other kinds of dictionaries which are – since they offer exclusively orthographically correct spellings – also used by users as orthographic dictionaries, irrespective of their intended function or use (e.g. an etymological dictionary). Thus, true orthographic dictionaries are those (monolingual) dictionaries in which it was the lexicographers' intent to make it possible for users to look up the correct orthographic spelling of a word.

grapholinguistics and other disciplines have neglected the relevance of dictionaries in the codification of orthography.

One last interesting problem with regard to rules and their codification must be addressed: codifications are open-ended, which means that orthographies are *open normative systems* or *open standardizations* (cf. Kohrt 1990: 129). This also concerns the question of when exactly a word can be regarded as a word, with the public often adhering to the belief that a word is only a word when it is listed in the dictionary.[243] This, of course, is a kind of prescriptive thinking that is rejected by linguistics – the existence of words and their status as words do not depend on being included in a dictionary. However, if words are not included in the dictionary, the question of their orthographically correct spellings is unanswered – it is orthographically indetermined.

Up until this point, we have dealt with *absolute norms*. They can be obeyed or not: if they are obeyed, a written utterance will be orthographically correct; if they are not obeyed, it will be orthographically incorrect. This distinction is categorical, there is no 'more or less correct'. I argue that this is not the only kind of norm, and that there are also more *loose norms*, recommendations that should be followed but whose rule explications are not explicit enough to always judge if something is orthographically correct or not. This distinction of absolute norms and loose norms corresponds with what Naumann (1990) terms orthography and *graphostylistics*, respectively, with orthography offering strict norms and graphostylistics giving recommendations.[244] I want to name two examples, one from German and one from Chinese. In German, not unlike in English, to mark a parenthesis, one can use either a pair of opening and closing parentheses <()>, two dashes <–>, or two commas <,> (but cf. Bredel 2011: 144f. for pragmatic restrictions for the use of the latter two). Which one has to be chosen is not orthographically determined, as all of them are regarded orthographically correct. They might be considered orthographic variants, since one can choose freely between them. Thus, through individual choices, one has the freedom to act creatively, so that Naumann's term *graphostylistics* fits this situation. Note, however, that the same cannot be said for orthographically licensed variants such as <Typographie> vs. <Typografie>. In this case, writers must make a definite choice intra-textually: once they have chosen <Typographie>, they cannot[245] alternate it freely with <Typografie> in the same text. (Of course, they can alternate it inter-textually.) In comparison, the three different kinds of demarcations for textual parentheses can be alternated freely within the same text, and this choice of freedom is what corresponds with the traditional meaning of *stylistics*.

The situation is a bit different in the Chinese example: an often-quoted challenge for the Chinese writing system is the integration of foreign names. In Chinese, basic shapes can be used solely for their phonographic value while their morphographic value is being ignored. This is often done when foreign names are transcribed, a process in which the phonological level is obviously foregrounded and morphological information is secondary. The challenge, now, arises because of the relatively small number of phonotactically licensed syllables in Mandarin and the resulting homophones. Because the Chinese writing system is morphographic, all

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[243] Consider, for example, the rules of the popular board game *Scrabble*. Player A might lay down a word and player B might 'challenge' it, claiming it is not a 'real' word. In this case, the rules state that the players must consult a dictionary (one they have formerly all agreed on) to check if the word is included. Only if it is included (and conforms to an additional number of rules: not being an abbreviation, not always being capitalized, not including hyphens or apostrophes, not being an affix that stands alone) does it count as a 'word' (cf. Scrabble Rules n. d., https://scrabble.hasbro.com/en-us/rules, December 19th, 2017).

[244] Note that the term *graphostylistics* has also been used in a different sense, e.g. by Spillner (1974), who used it to refer to graphetic style choices.

[245] 'Can' might not be the fitting verb for this situation. Of course, writers *can* do it, but it would probably be regarded as breaking the rules. Both of the spellings are orthographically correct, so in fact, writers have not made a mistake. However, consistency of spelling is also expected from writers and is, I would argue, also a part of orthography.

morphemes – many of which are homophonous – are written with distinct graphemes. In Modern Chinese, no new characters are created to write foreign names, "probably for typographic reasons and/or due to the lack of familiarity of newly created characters" (Hsieh 2015). There are certain guidelines 'to a good translation' which are *faithfulness*, *expressiveness*, and *elegance*. Corpus studies have shown that these guidelines are followed – if consciously or unconsciously cannot be said – by Chinese writers (cf. Hsieh 2015). What can be observed in the written practice of Chinese is that phonetic similarity of a foreign name is often sacrificed for semantic considerations. For example, no characters with negative connotations are to be used when transcribing a foreign name. On the other hand, foreign names are to be somehow marked to indicate their 'foreignness'. This can be done – and is frequently done – by using low-frequency characters. However, there are now prescriptive regulations by the Xīnhua News Agency that discourage the use of low-frequent characters. Other "prescriptive norms in China require that characters with too many strokes or heteronyms should not be used" (Hsieh 2015). Unfortunately, it is not straightforwardly clear just how binding the regulations of a news agency truly are and whom they are directed at or what norms Hsieh is referring to exactly in the last quote. What is clear, however, is that we are dealing with a form of *loose norms* and *graphostylistics* here. Even given these existing regulations, there are no general rules and also no singular rules for writing a given syllable. Thus, the two syllables /di/ and /mi/ in my nickname Dimi, for example, can be written with a variety of homophonous graphemes. The existing norms that no characters with negative connotations (whose perception and evaluation is often subjective anyway) and no rare characters are to be used reduce the number of possibilities, but they do not determine *one and only one* correct spelling. The general rules are too general, and there are no singular rule explications because foreign names are of course not included as entries in dictionaries. This means that in cases like this, there is a freedom of choice, and the loose norms leave open a number of variants that are all to be considered as orthographically correct – only in this case, I argue, this is not an absolute but rather a scalar category, with some spellings for /di/ as part of a name being perceived as more 'correct' than others.

Speaking of Chinese, let us turn to the problematic fact that most – if not all – of the preceding examples in this chapter have come from German, reflecting the fact that most contributions to orthographic theory have been made in the German literature and have focused on German. This, in sum, means that alas, Eurocentrism has not spared the module of *orthography*, either. One of the underlying problems for this has already been addressed: in the Anglo-American realm, and thus, in most of the relevant grapholinguistic literature published in English, *orthography* is treated as a descriptive term and as a synonym of *writing system*.[246] While this is not inherently erroneous, it is unfortunately reductive in a way that is misguided in descriptive linguistics: speaking of orthographies means (or at least implies to the knowing reader, while the author might have intended a different reading) speaking exclusively of standardized versions of writing systems. The result is 'descriptions' that are caged in prescriptivism. This problematic practice, in consequence, excludes crucial and interesting phenomena that fall beyond the scope of what is *correct* but that are still part of the system. As elaborated above, not all resources that a writing system offers its users are taken account of in its orthography.

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[246] Using *orthography* and *writing system* interchangeably within the same work – which numerous authors do – does not ameliorate the situation, it only goes to show that the differentiation between system and norm is disregarded, and it is up to the reader to decipher which of the two the terms ultimately refer to. It also ignores the fact that what is meant by *writing system* is often actually the *graphematic module*. Thus, treating *writing system* and *orthography* as synonyms is likewise problematic as it treats them as hierarchical equals and neglects the fact that an *orthography* is actually only (an optional) part of a multimodular *writing system*.

Accordingly, it is mostly authors that have some insight into the German grapholinguistic tradition that treat orthography as a prescriptive, normative phenomenon.[247] One of them is Florian Coulmas, who begins the overall commendable entry *orthography* in his *Blackwell Encyclopedia of Writing Systems* with the following words:

> Correct spelling and that part of grammar that deals with the rules of correct spelling. An orthography is a normative selection of the possibilities of a script for writing a particular language. All orthographies are language specific. As the most visible and most consciously learned linguistic subsystems, orthographies are often codified by official decree. (Coulmas 1996a: 379)

Leaving aside Coulmas's use of *script* which differs from the reading of the term in the present work, two passages in this introduction are baffling: orthography is a 'part of grammar' and it is a 'consciously learned linguistic [subsystem]'. While all the other aspects – the focus on correct spelling, being a normative selection, language specificity, codification by official decree – correspond with what has been described above, interpreting orthography as a part of grammar, I argue, is problematic. Because the concept of orthography can only be understood in combination with the concepts *writing system* and *graphematics*, it is necessary to look at these respective entries in the encyclopedia and analyze in what relation they stand. What is immediately obvious when reading the entry on *graphemics* (as an alternative term to *graphematics*, in this case used synonymously) is that it is interpreted solely as a designation of the "linguistic study of writing systems" (Coulmas 1996a: 176), meaning it is not treated as a term that also labels part of a writing system, thus leaving this spot open. Coulmas fills this open spot with one reading of *writing system*: "a writing system is what is also referred to as spelling, i.e. a system of rules underlying the use of the graphemes of a language" (Coulmas 1996a: 560). The only explicit difference between *writing system* and *orthography* in Coulmas's entries is that the former deals with 'rules of spelling' and the latter with 'rules of correct spelling'. Only the first is part of the grammar of a language system equipped with a writing system, the second is externally codified (although it certainly can, as mentioned above, be internalized and become part of the grammar).

An interesting section of Coulmas's entry on *orthography* deals with the crucial question of *what* can be standardized and regulated in different writing systems. Herein, as I will argue below, lies the crux of the Eurocentrist treatment of orthography – which, put quite simply, is just a reflection of the lack of research on orthography in general. Coulmas (1996a: 379) observes that "[i]n alphabetically written languages, the aspects of writing most commonly codified by means of orthographic rules are grapheme-phoneme correspondence, word division, hyphenation, capitalization, and the spelling of loan words". He goes on to note that "sound-letter correspondence is also a central component in orthographies of other writing systems" (Coulmas 1996a: 380), revealing that orthographies *of* writing systems[248] that are not of the alphabetic type share properties with orthographies of alphabets. To this, he adds that indicating vowels is orthographically relevant in Hebrew and Arabic, and that in Chinese, "the graphic composition of characters is a matter of orthographic regulation". While Coulmas hereby mentions that different writing systems call for different standardizing measures, the examples from non-alphabetic systems are sparse. Simultaneously, most of the aspects that are relevant in alphabetic writing systems have no correlate in non-alphabetic systems: capitalization is not present in any other type of writing system than alphabets, while word division is only present in some (but not Chinese, Japanese, or Thai, for example), and grapheme-phoneme-correspondence is also solely alphabetic (in syllabic systems, graphemes do not correspond with phonemes, but syllables; in Chinese, they do not directly correspond with any phonologi-

[247] However, German authors are not without fault, too. For example, a prominent German textbook (Fuhrhop [4]2015) that offers a description of the graphematics of German is inadequately entitled *Orthografie* (cf. Dürscheid 2016: 164), when it should of course be *Graphematik*.

[248] This passage strongly implies Coulmas interprets orthographies as parts of writing systems, much as I do in this thesis.

cal unit at all) – thus, these aspects are not or only marginally relevant when looking at a broader picture of orthographic regulations.

Twenty years after the entry in his grapholinguistic encyclopedia, Coulmas (2016: 41) declares that "[…] it is a legitimate question whether the structural differences between them [writing systems, D. M.] have any implications for prescriptive rules and attitudes". This is exactly what comparative orthography research needs to investigate: what is regulated in different writing systems and how can these differences in focus of regulation be explained? Are the differences of linguistic nature, that is, rooted in the writing systems that are regulated? Are they politically or culturally determined?

Central questions of a comparative orthography could be: Who is regulating, or in other words, who is in charge of the standardization of a given writing system? What are the motivations for standardization? In which areas of a given writing system does variation occur and are they the focus of standardization? Put more simply: which aspects in a given writing system *can* be standardized – and are all of them actually standardized or are some of them attended to more than others? If the graphematic solution space offers variants, how does an orthography (or the actors designing it) choose one (or multiple) of them? With respect to the topic of this thesis: does an orthography intervene to 'fix' or compensate unnatural features of writing systems? How do different orthographies respond to the system and its usage? Are they oriented towards usage? What drives orthographies – linguistic insights about the writing system? Politics? Another question that has not been addressed thus far: what was the motivation for a given orthography to be developed? What are the historical circumstances in which it began to arise?

As the remarks above as well as the listed questions elucidate, there are several concurrent discourses that are relevant with respect to orthography: as Eira (1998) described, these are not only *scientific discourses*, but also *political discourses*, and *religious discourses* (see Figure 21). Schimmel-Fijalkowytsch (2018) adds to those also discourses negotiated by the *media*. As orthography is a central concern of language policy, it is both a linguistic and a political matter. Thus, several agents or 'stakeholders' take an interest in it and want to be involved in making decisions that concern it: academics, government representatives, but also religious institutions such as missions or priesthoods.

A crucial discourse that is not pictured here but need not be forgotten is the *public discourse*. When people reflect on language in everyday life, it is often writing they think about, and very often specifically orthography, since their considerations are frequently of prescriptive nature: how do I write/spell this or that *correctly*? Orthography is much more concrete than other linguistic domains such as phonology or morphology. The material permanence of writing allows and sometimes even invites reflection about writing and orthography on a metalevel. Orthography is more tangible for the public: one reason for this is that it is commonly a main concern in primary education, and thus, most people in literal communities have come into intensive contact with it through having to acquire it. Other linguistic levels are usually not treated this consciously – unless one studies linguistics (or philological subjects). For the public, orthography thus often stands *pars pro toto* for language, and people feel they should have a say in what happens with their language.

Generally, when talk is of orthography, and especially of changes in the orthographic codification, many agents with different underlying motivations want to be part of the discussion. As Eira (1998: 175) illustrates, academics commonly have the linguistic fit of an orthography in mind, while politicians and religious authorities focus on other goals, respectively. A domain where the interests of linguists and politicians intersect is education: many orthographic reforms were put in place to facilitate the acquisition of reading and writing with the goal of heightening literacy rates (cf. for the example of the simplification of Chinese characters for this reason, Handel 2013). Even though the interests might be the same, the underlying motivations might differ: politically, an increase in literacy rates might lead to higher economic competitiveness, while linguistically, the goals of increased literacy might be more altruistic and idealistic, although linguists are aware of and want to underline their expert knowledge concerning orthography and do want to be seen and respected as integral parts of any efforts in changing anything language-related.

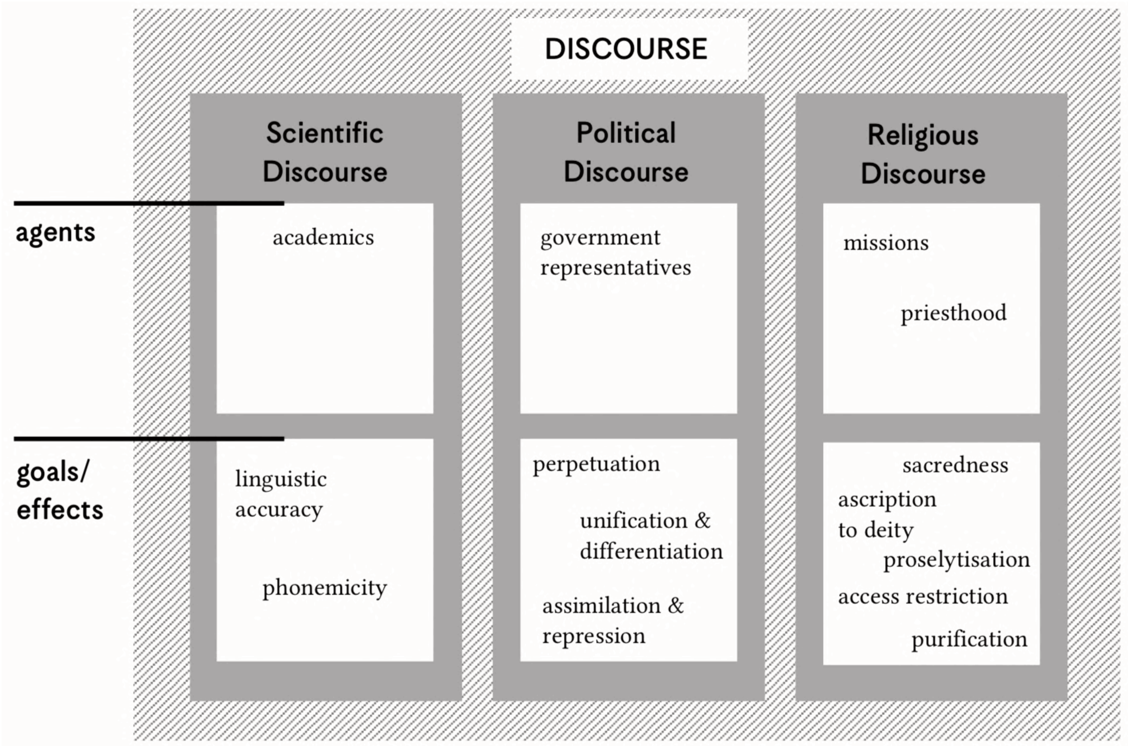

Figure 21: Discourses surrounding orthography, from: Eira (1998: 175)

The fact that there are various stakeholders involved means that changes of orthography are often surrounded by considerable (public) debate. The reform of German orthography in 1996 is a telling example, as it sparked a number of protests and even led to private citizens constitutionally challenging the reform (for detailed accounts on the reform(s) of German, see Johnson 2002, 2005; Schimmel-Fijalkowytsch 2018). Again, the motivations behind this outcry are multifaceted: while the public mostly wants to adhere to the version of an orthography they have grown accustomed to, linguists and professionals working in education might protest suggested changes that are not congruous with the underlying system and, in consequence, might not lead to a facilitation of acquisition processes because they obscure the systematics of a writing system.

This is not the place to discuss the different discourses surrounding orthography in detail. However, it should always be kept in mind that orthography is not only a linguistic matter, but also a social and thus sociolinguistic matter (cf. Unseth 2005; Sebba 2009). Seen as a central topic of sociolinguistics, the different facets (linguistic, ideological, political, religious, etc.) of orthography merge. Its resources have myriad functions and it has the potential to convey meaning on various levels – not just the denotative. Orthography is not only an optional module of a writing system but, as the standardized surface realization of a writing system, the central interface of a system and its users. While this thesis' focus is on its status as a module of a writing system and thus its linguistic functions, the potential of orthography to be instrumentalized as "social action" (Jaffe et al. 2012) shall at no point be undermined – in fact, when discussing the sociocultural fit of writing systems (cf. Section 3.3.3), this aspect of orthographies will come to the forefront.

2.3 Typology

The final section of this overview of theoretical grapholinguistics discusses a field for which, unlike for graphetics, graphematics, and orthography, comparison has never been alien, but constitutive. In fact, a comparative perspective as well as the dynamics between universality and diversity are what drives the field of writing systems typology. A considerable number[249] of writing system typologies have been proposed. The majority of them is structured very similarly, focusing on the same criteria and arriving at types that more or less resemble each other. Here, the most relevant of these typologies shall be critically examined and put into the context of the preceding description of the modules of writing systems. The results will serve as a backdrop against which the naturalness parameters of writing systems will be evaluated in Chapter 3.

However, before the typology of writing systems will be discussed, a closer look will be taken at the possible categories for a typology of the visual component of writing systems alone: *scripts*.[250] Please note that the categories presented in this context ought to be seen as very preliminary. They are solely descriptive, and they have been assumed deductively based on findings in the literature. As such, they are neither exhaustive nor have their cognitive implications been assessed yet. It will be one of the goals of Natural Graphetics (cf. Section 3.2) to uncover whether these categories are actually of relevance in the comparison and classification of scripts.

2.3.1 Scripts

In all honesty, there is no such thing as a 'script typology' as of yet. One could falsely get the impression that such a typology exists due to the different uses of the term *script*,[251] but if it is read the way it is in this thesis, as an inventory of visual basic shapes that can be used for the materialization of a writing system – examples being Roman script, Chinese script, and the kana inventories of Japanese –, then no actual typologies exist. One laudable, though effectively misguided effort at a 'taxonomy of alphabets and scripts' comes from Earl M. Herrick (1974: 5), who stated over forty years ago:

> Linguists, typographers and others who work with written language do not presently have any adequate system of classification for describing similarities and differences among [...] scripts which are used to write languages.

Herrick attempts to change that with his taxonomy. Although he mentions both linguists and typographers in his introduction, the latter of which are predominantly interested in the visual aspects of writing, he strays far from my definition of *script* and arrives at an unfortunate mix-

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[249] Note that contrary to my assessment of the situation, Joyce & Borgwaldt (2011: 1) claim that "historically there have been relatively few proposals for typologies of writing systems", although in their short introduction alone, they list thirteen typologies. Whether that is many or few may lie in the eye of the beholder.

[250] Although this thesis is written in English, I want to point out a terminological problem in German pertaining to the typology of scripts vs. writing systems. In German, a script is commonly referred to as *Schrift*, a highly ambiguous term serving also as the designation of the global phenomenon writing in general. A writing system, on the other hand, is unambiguously referred to as *Schriftsystem*. However, for the typology of writing systems, the term *Schrifttypologie* is in use. I argue that for a consistent terminology, the typology of writing systems should be *Schriftsystemtypologie*, while *Schrifttypologie* should be reserved for the (yet lacking) typology of scripts.

[251] Gnanadesikan (2017), whose findings will be central in the following section on writing system typology, calls types of writing systems *scripts*, so she calls the phonographic type *phonemic script*. This goes against the reading of *script* as adhered to in this thesis. What I call *script* is, for Gnanadesikan (2017: 15), a *signary*.

ing of the material and the linguistic levels. This becomes particularly obvious when he lists three criteria of 'alphabetical similarity' for arriving at a taxonomy of scripts:

1. Similarity in the basic shapes of letters.
2. Similarity in the correspondences between letters and phonemes.
3. Similarity in the alphabetical orders of letters. (Herrick 1974: 12)

In a pure script typology, only the first of these criteria should matter. The second would already be part of a typology of writing systems in which, conversely, the first criterion can be ignored.[252] Note the interesting terminology Herrick employs here: for him, *basic shapes* are exactly what they are in my conception, while he uses *letter* as a functional term, probably as a synonym of the analogical reading of *grapheme* (cf. Section 2.2.2.1). That he follows the analogical rather than the referential view becomes apparent in his second criterion, where he basically invokes grapheme (or letter)-phoneme-correspondences. His third criterion is interesting insofar as it is neither relevant for a typology of scripts nor a typology of writing systems. Examining the order of the basic shapes in an inventory is a historical matter, and ultimately a matter of convention. Consequently, the order in which elements are grouped in a script or writing system[253] does not have an impact on the fundamental criteria that allow assuming typologies for scripts on the one hand and writing systems on the other.

Let me illustrate an example of how Herrick's taxonomy works in practice. The taxonomy's hierarchical levels are the following: *alphabets*[254] < *scripts* < *genera of scripts* < *families of scripts*. So first, Herrick groups a number of 'alphabets' together, for example Czech, Dinka, English, Hawaiian, Icelandic, Kazakh, Malay, Navajo, Serbo-Croatian, Spanish, Swedish, and Turkish, and assigns them to a 'script' called 'Neoroman'. The assignment of all these alphabets to one script is based on the fact that "their letters must have almost the same alphabetical orders and almost the same pronunciations, and they must be embodied almost entirely by characters with identical basic shapes" (Herrick 1974: 16). The same criteria are applied for the assignment of scripts to genera and genera to families. However, the level of similarity decreases: for two alphabets to be assigned to one script, Herrick uses the attribute "almost the same", while for two scripts to be assigned to a genus, he only speaks of "similar". The 'Neoroman' script is grouped together with the scripts 'Paleoroman' (consisting of the alphabet Latin), 'Fraktur' (consisting of German) and 'Irish' (consisting of Gaelic), and together they form the genus 'Romanoid'. Finally, on the hierarchically highest level, Herrick groups together the three genera 'Romanoid', 'Cyrilloid', and 'Hellenoid', and calls the family 'Hellenic'. What this classification implies is that Herrick's unique blend of criteria leads to a taxonomy that highlights genetic affiliation. It is not so much a typology of scripts, then, as more of a genealogy of scripts and writing systems.

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252 Interestingly, around the same time, Herrick (1975: 537) wrote in a different contribution: "A linguist should be able to analyze a script, and the contrastive features which distinguish its marks from one another, without having to deal at the same time with the linguistic features peculiar to any one language". Ironically, in his 1974 taxonomy, he fails to do exactly that.

253 It is not obvious which of the two is ordered: is the conventional order inherent to scripts or writing systems? I would argue that it is the first, as the ordering of units is not dependent on the specific writing system, staying consistent across various writing systems that use the same script: for example, 'letters' of different alphabetic systems using Roman script have more or less the same order, with the exception of units that have been added – for example |ü| in the German or Turkish versions, |å| in Scandinavian versions or basic shapes modified by hačeks such as |č| in versions used by Slavic writing systems. These additional units have to be integrated into the order of the initial, original set.

254 Herrick's mixing of the material and functional levels is nowhere clearer than in his use of *alphabet*. The 'smallest' individual inventories that Herrick considers – Czech, English, German, etc. – are in fact alphabetic writing systems. They do not differ in their use of script, which is exactly why Herrick groups them together as 'scripts', specifically under 'Romanoid'. However, they are identified as different Romanoid scripts in Herrick's conception since they represent different writing systems that serve different languages. Following Weingarten's (2011) analysis of writing systems as combinations of scripts and languages, the base level of Herrick's *script* typology is determined by different languages instead of different scripts.

In sum, because of his flawed choice of criteria and his mixing of material, functional, and conventional aspects, Herrick's proposal cannot be regarded as a typology of scripts. In his suggestions for future research, he claims that his taxonomy is only preliminary and that it "will require much work by many hands to become a useful taxonomy of writing systems" (Herrick 1974: 29). In finally using the term *writing system* in these closing remarks, Herrick reveals that his distinction between *script* and *writing system* is fuzzy and that he does not appear to be sure of what exactly the results of his endeavor represent.

In an elaborate volume on the diversity of language and writing titled *Der Turmbau zu Babel* (*The Tower of Babel*), an overview is given of the 'writing systems of the world' (Seipel 2003: 10-11). However, what is actually given is, similar to what Herrick arrived at, a genealogy (cf. Figure 22). A presentation like this highlights the historical connections between scripts and may be called upon, for example, when the striking visual similarity of two scripts has to be explained. However, as for languages, for scripts, too, a genealogy does not equal a typology. What even *is* a typology of scripts, then, and what are the relevant criteria that help assemble it?

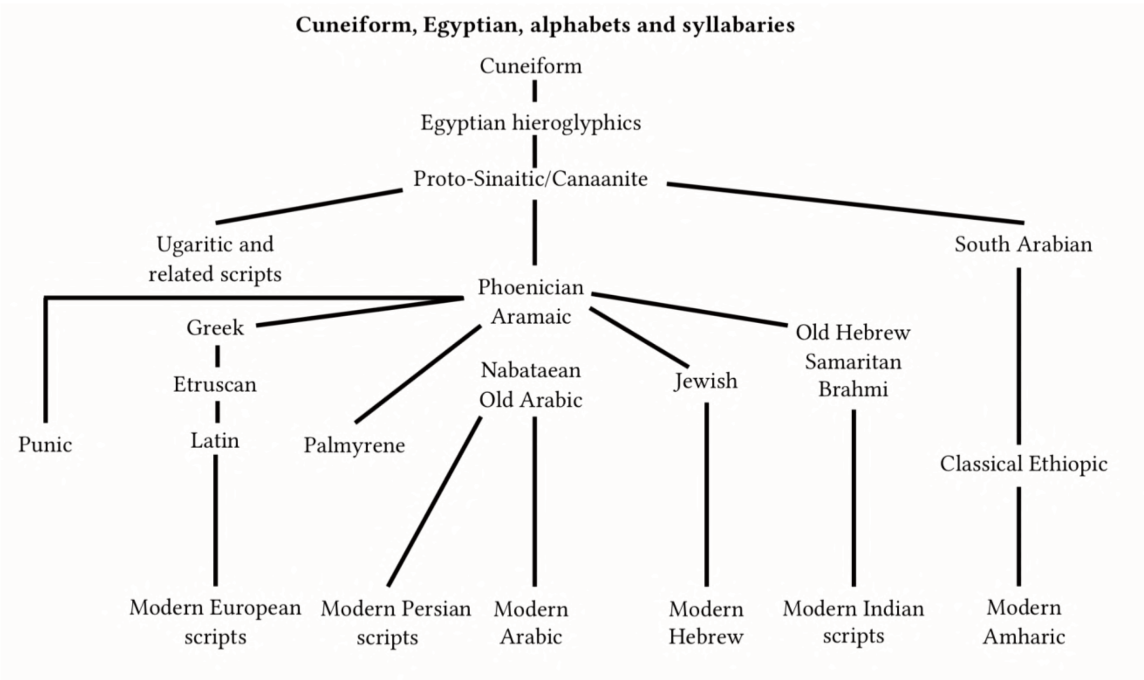

Figure 22: Genetic classification of scripts, adapted and translated from: Seipel (2003: 10-11)

When scripts are defined as visual inventories devoid of linguistic information, solely visual categories must be provided for a typology. There are multiple such candidates for a visual base criterion, all of which lead to different typologies. Before these can be assessed, however, it must be assessed first what the use of such a script typology would even be in general and how grapholinguistics could benefit from it.

The kind of script typology that is proposed here is *descriptive* as it is based on descriptive visual criteria. As such, it falls into the realm of script-graphetics as presented in Section 2.2.1.1. This corresponds with the nature of the existing typologies of writing systems which are equally descriptive in nature. It is only in a second step that a different perspective can be adopted: once descriptive categories have been established, their repercussions on the production and perception of scripts can be studied. In this vein, a descriptive typology of scripts is a deductive predecessor to a Naturalness Theory of scripts, a *Natural Graphetics*. It will be interesting to test whether the categories that were proposed descriptively actually have a bearing on the physiological and cognitive processing of scripts, which will be assessed in Section 3.2.2. To anticipate a crucial distinction that helps organize the different levels of naturalness, the fit of scripts can be assessed on, as mentioned, a physiological and cognitive level, and also a sociocultural level. The third fit, the *linguistic fit* (cf. Section 3.3.1), cannot be evaluated for scripts, since scripts – unlike writing systems – do not have a linguistic function on their own. What *can* and will be assessed, however, is the systematicity of a given script, i.e. how the features of a script are spread throughout its basic shapes and, in sum, how coherent the script is as a system.

Two different types of visual categories must be distinguished according to the level at which they are located: at the *micro-level*, the focus is on features of individual basic shapes. What is analyzed, thus, is a basic shape within its segmental space. The features relevant at this level are *individual features*. Arguably more crucial for the typology of scripts, however, is the *macro-level* at which the *relational features* of basic shapes in a script are examined. This is possible and reasonable if scripts are seen as visual systems. How distinctive a basic shape is, for example, can only be assessed when its relation to the other basic shapes of an inventory is considered. In sum, the relational features of scripts lead to an overall value of the above-mentioned systematicity that allows an evaluation, among other things, of how natural given basic shapes are within an overall inventory or what potential new basic shapes that are being added to a script could look like (cf. Watt 1983a; cf. Section 3.2.1).

Many of the potential visual categories for a script typology are informed by the spatial arrangement of basic shapes. When only a single segmental space and the individual features of a basic shape are investigated, several both quantitative and qualitative questions arise. Some of the quantitative questions read: how many elementary forms (straight lines, curves, dots) does a basic shape consist of? How much of the segmental space is filled by visual information in contrast to empty space? Qualitative questions concentrate on the organization of the visual material: how can a basic shape be segmented, *which* are its elementary forms? How are these arranged within the segmental space, and is the segmental space internally structured complexly, too, as exemplified by the four-line-schema in Roman script or the possible subspaces that subsegmental components can occupy in Chinese hanzi and Japanese kanji (cf. Section 2.2.1.2)? Are the elementary forms of the basic shape hierarchically organized similarly to how Primus (2004, 2006) proposed for Roman script? In this vein, is there a hasta/head and a coda? Although the following is primarily an overall relational feature, it can also be asked individually when the spatial arrangement of a single basic shape is assessed: does a basic shape have a direction? Is a basic shape intrinsically symmetrical, like |A| or |o|? What is the topology of the elementary forms in relation to one another: how and where in the segmental space are they connected? How can, for example, the difference between |T| and |X|, basic shapes that consist of two straight lines each, be described and formalized?

Even before they contribute to a hypothetical typology of scripts, these questions can be used to describe individual basic shapes and compare basic shapes with each other. Questions that regard the whole script and lead to a discovery of relational features are, among others: is there extrinsic symmetry, i.e. are there basic shapes that are treated as distinct in the script but differ only in orientation, such as |p| and |q|? What is the overall 'character' of a script: is it more angular or round? Consider, for example, the overall visual character of the scripts in the two figures below. While in Georgian and Telugu (cf. Figure 23), the basic shapes are overall very curved, as noted by a user in a forum on the internet, the Chinese hanzi as well as the basic shapes they have influenced – the Japanese kana inventories[255] and Korean Hangul – are very angular in character (cf. Figure 24).

[255] The kana inventory pictured in Figure 24 is *hiragana*; in Japanese, it was previously also called *onnade* 'women's script' because it was predominantly used by women while men were using Chinese characters (cf. Coulmas 1996a: 207). Another reason why it was called 'women's script' has to do with the fact that it is visually more curved and 'smoother' in nature than the more angular *katakana*, which are not pictured (cf. Dürscheid 2016: 87; Stalph 1996: 1420).

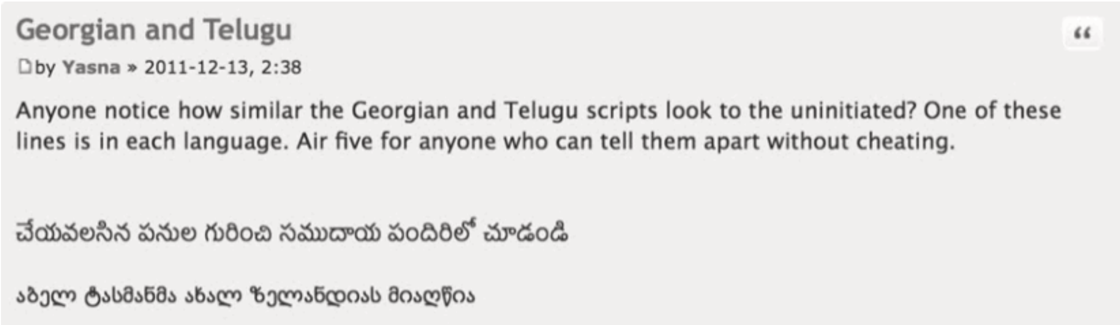

Figure 23: Roundness of the Telugu (above) and Georgian (below) scripts, from: https://forum.unilang.org/viewtopic.php?t=35659 (February 7th, 2018)

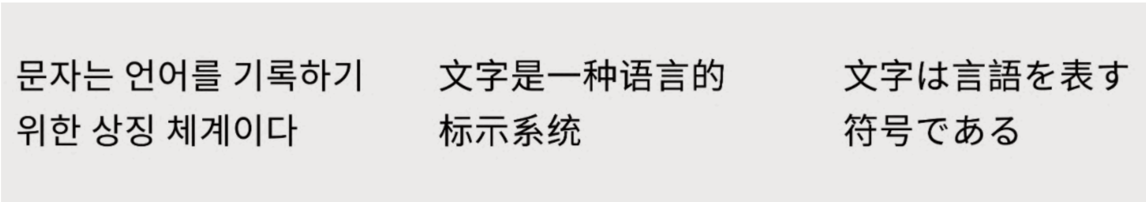

Figure 24: Angularity of the Korean Hangul (left), the Chinese (middle) and the Japanese kanji and katakana scripts (right), from: https://storage.googleapis.com/spec-host-backup/mio-design%2Fassets%2F1Fv3Pph5qFaeOLFhbXTPDTo0OYAaalvbA%2Flanguage-2.png (February 8th, 2019)

The questions listed above concerning the micro- as well as the macro-level can be systematically bundled as features as done in Table 3. After determining the individual feature values for each basic shape in a script, the result can be used to establish typologies based on each feature. Which of the features – or which bundle of features – is chosen as a base is, at this point, still a conscious, but arbitrary choice of the typology's architect. However, these suggested scriptual features will be reevaluated in the proposal of a *Natural Graphetics*, where, after their relevance for processing has become clear(er), the foregrounding of one of those features for a cognitive and in turn descriptive typology of scripts might become an easier task.

Table 3: Possible categories for a script typology

micro-level individual features	QUANTITA-TIVE	1. number of elementary forms	How many elementary forms/segments does a basic shape consist of?
		2. density/grey-scale value	How much of the segmental space is filled with graphic material and how much of the segmental space is empty?
	QUALITATIVE	3. subsegmental structure/hierarchy	Can an internal structure be made out in a basic shape? Is there a subdivision of the segmental space in smaller spaces? (This may only be possible to evaluate in relation to other basic shapes, so it might or at least might *also* be a relational feature instead.)
		4. topology	How are the elementary forms/segments in a basic shape arranged? What are the relations between them? How do they connect/intersect? (If they connect/intersect.) And how are they spatially arranged within the segmental space?
		5. orientation/ directionality	With regard to the subsegmental structure (feature 3 above), can an “orientation” within the segmental space be recognized? For example, |b| would be right-orientated while |d| is left-orientated.
		6. intrinsic symmetry	Is a basic shape intrinsically symmetrical (whether horizontally, vertically or point-symmetrically) such as |A| or |M|?
		7. roundness/angularity	Is a basic shape rather curved or angular in character? This depends on the elementary forms (and their hierarchy) and whether they are predominantly angular or round.
		(…)	
macro-level relational features	QUANTITATIVE	1. number of basic shapes	How many basic shapes are there in a script?
		2. number of (distinctive) features	Is there a set of visual features that act contrastively throughout all the basic shapes? And even if not, what are the distinctive features when subsets of a script (e.g. two basic shapes such as |F| and |E|) are being analyzed? In general: what are the constitutive features of the basic shapes in a script?
		3. (in)completeness	Given the features, are there any possible, well-formed basic shapes that are as yet not part of the script? How many of these systematic gaps are there in a script?
	QUALITATIVE	4. distinctiveness	How distinctive are the basic shapes? Is there a great deal of similarity or dissimilarity between them?
		5. visual cohesiveness, systematicity	Conversely, is the script a sound visual system? Do the basic shapes of a script have enough in common visually to be perceived as being members of the same inventory?
		6. subsegmental structure	Also (or maybe exclusively) at the relational level, the question must be asked whether there is a systematic subsegmental structure or hierarchy in a script (e.g. the hasta-coda-principle in the Roman script) that can also inform the well-formedness of (existing or non-existing) basic shapes, i.e. the (graphetic) graphotactics of a script.
		(…)	

2.3.2 Writing systems

This section gives an overview of the most relevant proposals for a typology of writing systems and collects open questions. Although a lot of work has been done in the field and some typologies have more adherents than others, there is no general consensus as to which typology is regarded as the 'right' one. Gnanadesikan (2017: 14) goes as far as claiming "[t]he typology of writing systems is not a topic on which any two grammatologists appear ready to agree". While in reality, the situation might not be as dramatic, this field is undoubtedly fraught with disagreements regarding several aspects. This probably lies in the selective nature of typologies and typology-building that was already addressed in the context of a nascent typology of scripts. As Coulmas (1996a: 520) notes, "typologies are necessarily theoretically informed and selective focusing on particular properties of writing systems than on others". The criteria for assuming any typology should be informative and analytically valuable. Not useful are criteria such as genetic affiliation (see above for scripts) or geographic origin, so terms such as 'Chinese-derived writing' or 'Central American writing' are not valuable typologically[256] (cf. Coulmas 1996b: 1381).

Most typologies of writing systems have focused on the smallest units of writing systems, written units that represent "the system's elementary signs, words or morphemes or syllables or phonemes" (Coulmas 1996b: 1381). Coulmas calls these smallest written units *basic units of operation*. This corresponds with my conception of the grapheme, which, following the linguistic value criterion, represents a linguistic unit. In this vein, the first seven chapters in Daniels's (2018) comprehensive work on the writing systems of the world are also based on linguistic units (syllables, segments, consonants, moras, clusters, morphemes, and words, in that order) and the writing systems that represent them. However, this is not the only possible criterion for assuming a typology. Many other possible criteria are disregarded in most typologies:

> Typologies do not usually refer to higher-level organizational principles of writing, e.g., chapters, sections, paragraphs, and sentences by means of which text is segmentable, or properties of text such as direction (left, right), axis (horizontal, perpendicular) or lining (top to bottom, bottom to top). Accordingly, punctuation is generally disregarded in typologies of writing systems.
> (Coulmas 1996b: 1381)

Gnanadesikan (2017: 14-15) also mentions some of the possible criteria other than the basic units of operation, and her list shows an overlap with Coulmas's: "a set of signs, the spatial arrangement of the signs, [...] and language-specific orthographic rules by which the signs are interpreted". As Coulmas (1996b: 1386) remarks, it is necessary to prioritize some criteria at the expense of other criteria. This practice of devaluing most of the criteria in favor of singling out the role linguistic units play for graphemes has led to an overall rough nature of typologies in which many distinctions are simply overlooked. For this reason, Weingarten (2011: 12) concludes:

> The typology of writing systems is still in its beginnings. The types proposed to date [...] may highlight certain basic characteristics of a writing system but they cannot, for example, elucidate the fundamental differences between the French and the Italian writing system, which both belong to the alphabetic type.

In order to arrive at a more fine-grained typology, Weingarten suggests comparing writing systems, and not only those writing systems that differ fundamentally, as is done in the present thesis, but also similar ones that are, in most existing typologies, categorized as belonging to the same type (cf. Lindqvist 2001 for a comparison of Scandinavian writing systems and Meisenburg 1996 for Romance writing systems).

Figure 25 lists some of the major typologies of writing systems also mentioned by Joyce & Borgwaldt (2011) (for a more detailed overview of these typologies and a number of useful figures, see also Voß 2003). The major distinction that is made in all of these typologies is be-

[256] Of course, there is a possibility that there exist areal phenomena or features that would be interesting to analyze from a typological perspective.

tween writing systems that are *phonographic* and writing systems that are *non-phonographic*.[257] For the latter category, different names have been proposed, most prominently *logography* and *morphography*. Following Sampson's (2015) view that the basic units of writing may refer to morphemic units, but not polymorphemic units (such as words), I use morphography (cf. also Joyce 2011).

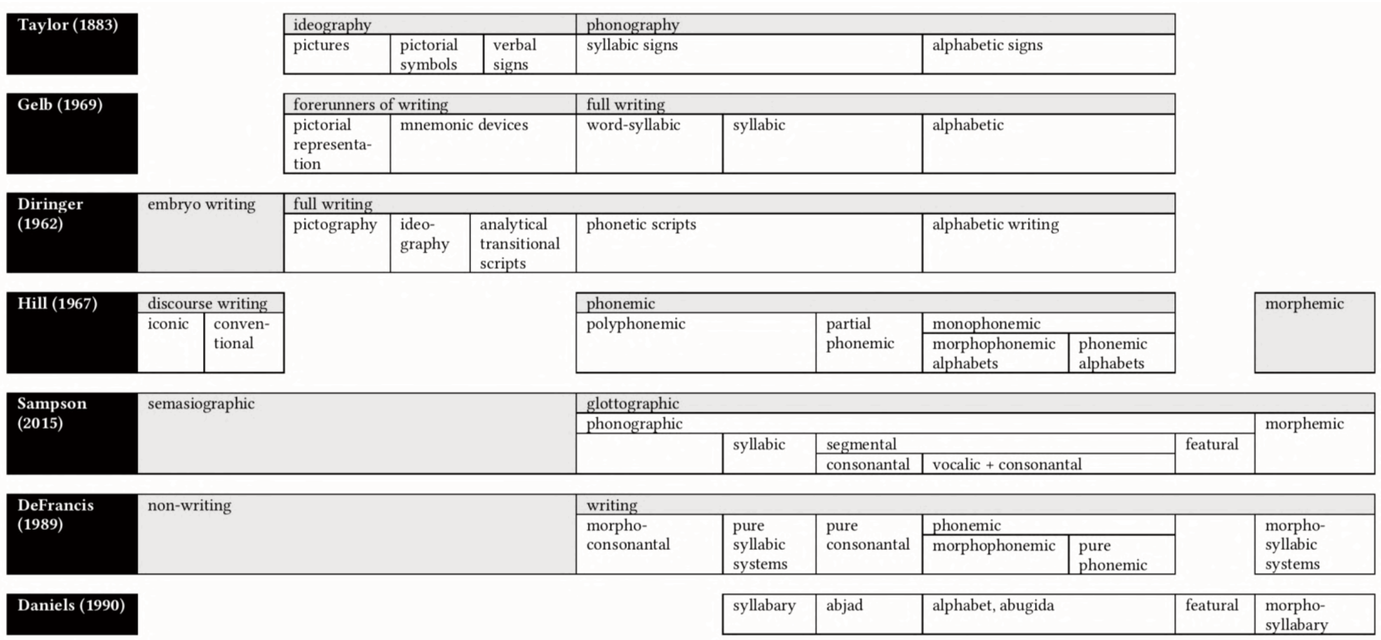

Figure 25: Prominent writing system typologies

What is obvious from this collection of typologies is that overall, there exist four major types, three of them *phonographic*: syllabic, segmental (phonemic), and a marginal, sometimes included subsegmental (featural) type. The fourth important type is *morphographic*. The most widely accepted proposals of subtypes of the phonographically segmental branch come from Daniels (1990, 1996, 2017, 2018), who, in addition to alphabets, assumes abjads and abugidas: in an *abjad*, "the characters denote consonants (only). […] In an *abugida*, each character denotes a consonant accompanied by a specific vowel, and the other vowels are denoted by a consistent modification of the consonant symbols" (Daniels 1996: 4, emphasis in original). These designations are not self-explanatory: analogously to *alphabet*, Daniels coined them by using the names of the first units of the Arabic writing system (in order: a–b–ja–di) for *abjad* and the Ethiopic writing system (a–bu–gi–da), which is an *abugida* system (cf. Daniels 1990: 729f.).

Gnanadesikan (2017: 14, emphasis in original) echoes Weingarten in arguing that these types proposed by Daniels are not fine-grained enough, claiming that "a short list of simple one-word names, like *alphabet*, *abjad* and *abugida*, does not capture the full range of segmental scripts or the relationships between them". In her sound and impressive contribution, Gnanadesikan evaluates a number of categories (similar to Faber 1992) that lead to finer distinctions between types that are not included in the *alphabet-abjad-abugida* trichotomy. Table 4 lists her categories as well as the terms that she proposes for these categories' different values. The resulting terminology is characterized by rather long designations for the individual types. Although they, similarly to my proposed terms for the types of allography, appear cumbersome

[257] Arguably the most important typology omitted here is Sproat's (2000: 142). Sproat proposes a two-dimensional typology in which one axis specifies the type of phonography (consonantal, polyconsonantal, alphabetic, core syllabic, syllabic), and the other axis informs about the amount of logography, with writing systems such as English exhibiting no logography and systems such as Sumerian or Japanese being positioned at the other end of the spectrum, as logography is a constitutive feature in them.

and do not make for elegant one-word designations such as Daniels's, they are conceptually precise, and from a scientific standpoint, that is the favorable quality. In Gnanadesikan's terminology, an *alphabet* is a fully vowelled linear segmentary, an *abjad* is a consonantal linear segmentary, and an *abugida* is a mostly vowelled āksharik segmentary, although Gnanadesikan (2017: 32) notes that mostly vowelled really means 'all vowels but one'. Even though I believe the more precise terms are valuable when speaking about individual systems, Daniels's terms *alphabet*, *abjad*, and *abugida* still work as somewhat vague superordinate terms that subsume a number of different systems, although it must be noted that some systems are outside their scope.

Table 4: Typological categories and terminology, from Gnanadesikan (2017: 28), slightly modified[258]

Category	Values	Term
Characters (basically) represent segments	Yes	Segmentary/Phonemic writing system/Segmental writing system
	No	Other (e.g., Syllabary)
Other structures represented (other than those in 'higher-order structures' below)	Features	Featural
	Moras	Moraic
	None	(omit)
Higher-order structure represented	Peak/margin	Āksharik
	Syllables	Syllabically arranged/spaced
	None	Linear
Inclusion of vowels	All	Fully vowelled
	Most	Mostly vowelled
	Some	Partially vowelled
	None	Consonantal

For German and Arabic, for example, Gnanadesikan's proposal offers unambiguous categorical assignments: German is a prototypical alphabet, and thus a *fully vowelled linear segmentary*. Arabic is a *partially vowelled linear segmentary*. Thai is an interesting case. It is tempting to call it a *mostly vowelled āksharik segmentary*. However, only some of the vowels are represented as signs that are secondary in that they are smaller and/or appear above/below the consonant. The remaining vowels are of the same size as the consonants and appear linearly on the base line, just like consonant graphemes. Thus, Thai is a bit of a mixture when it comes to the representation of vowels: a *mostly vowelled āksharik/linear segmentary*.

Because non-segmental phonographic as well as morphographic systems were not in the scope of her proposal, I want to discuss an extension of Gnanadesikan's approach that includes all types of writing systems.

Gnanadesikan's first category, segmental vs. non-segmental, is constitutive for all non-segmental types of writing systems. In this category are syllabic writing systems as non-segmental phonographic systems, and morphographic writing systems as non-segmental non-phonographic systems. Ultimately, this results in a trichotomy again: segmental vs. syllabic vs. morphemic. As was already established in the discussion of the graphematic syllable (cf. Section 2.2.2.3), syllabic writing systems such as Cherokee or Vai are naturally what Gnanadesikan calls *syllabically spaced*, since there are empty spaces between graphemes and these graphemes represent phonological syllables. However, the same cannot be posited for morphographic systems: frequently, since Chinese is the most prominent example, and in Chinese, a single morpheme almost always corresponds with a single syllable, the overall type of writing system is

258 Since Gnanadesikan uses *script* in a different sense, I changed the term in the table to *writing system*. Conceptually, we speak of the same phenomenon.

referred to as ‘morphosyllabary’. Thus, Chinese, with notable exceptions,[259] is also syllabically spaced, although it must be noted that this is only an *indirect* consequence of the fact that it is actually morphemically spaced. The same cannot be said for the morphographic kanji of the Japanese writing system. These have originally been borrowed from Chinese, but in the native *kun’yomi* readings, the morphemes of Japanese are mostly polysyllabic. This actually makes it uncommon that a morpheme corresponds with only one syllable. Thus, only a part of the Japanese writing system – the syllabic part, as materialized by the kana inventories – is syllabically spaced. The morphographic kanji part is (predominantly) not.

The other categories in Gnanadesikan’s approach do not concern either syllabic or morphographic writing systems. In her exclusive treatment of segments, she also includes only those ‘higher-order structures’ that can be represented within the segmental space. Thus, the graphematic syllable as defined for German in Section 2.2.2.3 is, as a polysegmental ‘unit’, not included. Polysegmental units fall into the scope of what Coulmas (1996b: 1381) called “higher-level organizational principles of writing”, a domain usually not addressed by typologies. However, as I stated above, the story of graphematics and writing in general is anything but done with the grapheme, which, as the “basic unit of operation”, is only the base criterion for existing typologies. Supported by the extensive preceding discussion on the grapheme as well as the graphematic syllable, the graphematic word, and the graphematic sentence, I want to modify existing typologies by taking into account exactly this question of higher-level organization in writing. The basis for my argumentation will be Table 5.

Table 5: A typology of writing system inclusive of higher levels

level	writing systems / TYPES / linguistic units		**Korean** (FEATURAL) ALPHABET	**German** ALPHABET	**Thai** ABUGIDA	**Arabic** ABJAD	**Japanese** (kana) SYLLABARY	**Chinese** MORPHO-GRAPHIC
phono-logical	*feature*		[x]	[x][5]				
	phoneme	*consonant*	[X]	X	X	X		
		vowel	[X]	X	x[1]	(x), X:[2]		
	syllable		X	[X]	[X]	[X]	X	X[3]
morpho-logical	*morpheme*		[X]	[X]	[X]	[X]	[X]	
	word		X	X	[X]	X	[X]	[X][4]
syntactic	*sentence*		X	X	X	X	X	X
textual	*larger units*		X	X	X	X	X	X

Legend

X = signifies that a linguistic unit is represented in writing

x = signifies that a linguistic unit is represented in writing by a graphematic unit that is graphetically or *graphematically secondary*

( ) = indicates that this linguistic unit in writing is *optional*

[ ] = indicates a unit that is *not* made visible by empty spaces, i.e. does not fulfill the *empty space criterion*

= linguistic units that are the basic units of representation in *graphemes*

= these linguistic units are *not* represented in a writing system

[259] Mair (2011) describes a number of Chinese characters that are monomorphemic but polysyllabic. One example is <圕> *túshūguǎn* ‘library’, where one character represents a trisyllabic morpheme. Mair calls the firm belief that Chinese is monosyllabic “the myth of innate monosyllabism of Chinese language, and even of Chinese writing, a myth with which students are indoctrinated worldwide” (cf. also DeFrancis 1984; Behr 2018).

Notes

[1] There is a minuscule x in this cell because in Thai, like in other abugidas, the vowels are dependent on the consonants, meaning they cannot occur alone. In some cases, they are also graphetically secondary, as they are often relatively smaller in size and attach to the consonants. In Thai, however, there are also vowel graphemes that are equal in relative size to the consonant graphemes and occupy their own segmental space.

[2] In Arabic, long vowels are always graphematically represented, which is signified by an uppercase X followed by a colon, which in the IPA indicates vowel length. Short vowels are commonly not represented, although they can optionally be written and in some contexts are written (such as material for reading acquisition or teaching material for Arabic as L2). If they are written, they are graphetically secondary to the consonant graphemes, both in their placement above or below consonant graphemes as well as in their size, which is why there is a lowercase x is in parentheses.

[3] In most cases, one morpheme in Chinese represents one syllable. Thus, syllables are written in Chinese. Note, however, that the representation of syllables is not direct, as it is only a consequence of the representation of morphemes. Since morphemes have phonological representations, which in this case are syllabic, graphemes that represent morphemes indirectly signify syllables. This cell is occupied in this table only because we are considering the direction *writing → language*. Because of the vast homophony of Chinese and thus, the polysemy of syllables, the other direction of analysis would not be feasible: while morphemes have a uniform representation through graphemes, a single syllable can often be written with many graphemes.

[4] In many cases, in Chinese, a single morpheme can already represent a word. If this is the case, the two units merge and a word is graphetically represented through preceding and following empty spaces. However, many words in modern Chinese are polymorphemic and thus, are written with more than one grapheme. In these cases, the polymorphemic and polygraphemic words are not separated from other words by empty spaces and, thus, the word in its common sense is not an unmarked graphetic or graphematic unit in Chinese.

[5] Primus (2004, 2006) postulates a form-function-correlation for subsegmental components of lowercase basic shapes from Roman script, i.e. that certain elementary forms that exhibit certain features represent phonological features such as place of articulation. This will be discussed in Section 3.3.1.2.

In Table 5, one representative writing system of each type is included. Here, they are referred to with Daniels's terms, partially because of formatting reasons and limited space inside the table cells. This typology highlights not only that "basic unit of operation" in writing systems is just another term for *grapheme*, but also illustrates higher-level linguistic units that are represented in the respective systems. This confirms that the *strict layer hypothesis* that Evertz (2016: 392) transferred from phonology to graphematics actually holds not only for the alphabetic German writing system, but for all writing systems: in a suprasegmental hierarchy, here understood as a polysegmental hierarchy, a given unit must always consist of units of the immediate lower level while it serves simultaneously as a constitutive part of higher-level units itself. Thus, the graphematic representation of phonological syllables, if it is achieved polysegmentally, must at a lower level consist of graphemes, while at a higher level it forms part of the graphematic representation of morphemes. Another aspect that is emphasized in this typology is the interaction between graphetics and graphematics and the central question: which graphematic units are simultaneously graphetic units, i.e. which graphematic units are visually salient?

The cells with a black background in Table 5 reveal which units the graphemes in a given writing system represent. In the segmental writing systems, which Gnanadesikan fittingly terms *segmentaries*, these are phonemes, with exactly the fine-grained distinctions that Gnanadesikan underlined: German and Korean are fully vowelled, Thai is mostly vowelled, and Arabic represents only one type of vowels. Notes (1) and (2) above give more information on the special situation in Thai and Arabic – in short, the minuscule x's, in contrast to the majuscule X's, showcase that vowel graphemes are secondary while consonant graphemes are primary. In Japanese, graphemes represent syllables, and in Chinese, graphemes represent morphemes and, due to the morphosyllabic nature of Chinese, simultaneously syllables, cf. note (3). This is not the case for Japanese kanji, which are not included in the table; here, graphemes, at least in native readings, prototypically represent only morphemes, not syllables.

This table illustrates another almost universal trait of writing systems: graphemes, as the smallest functional units, are simultaneously the smallest freestanding visual units that occupy segmental spaces and are constituted by the smallest empty space, the empty space between basic shapes. This is marked in the table by the fact that the X's (or x's) are not enclosed by square brackets. The first notable exception, here, is Arabic, in which the basic shapes occupy segmental spaces but are mostly connected. Therefore, there is no empty space between all basic shapes. The smallest empty space does become visible, however, between basic shapes that are not connected. If it is produced, it is relatively smaller than the empty space between words. The second notable exception is Korean. In Korean, the graphemes are basic shapes that graphematically represent both vowels and consonants, i.e. phonemes. However, as Gnanadesikan also notes, they are syllabically arranged. It is not the consonant and vowel graphemes, but the syllable blocks that they form that occupy segmental spaces. Korean, thus, is the only example where the segmental space is not filled by graphemes, but a unit of writing that corresponds with a phonological syllable. However, as the *strict layer hypothesis* predicts, these syllables consist of visually subsegmental vowel and consonant graphemes, which can be extracted transparently from the syllables. This is also the reason Korean is not to be considered a syllabary, at least not structurally. What it constitutes functionally is a different story (cf. Coulmas 2016: 45).

Note that in Korean, there is a level beneath the segmental level, the so-called featural level (cf. Sampson 2015: 143-166). It refers to the fact that the basic shapes that graphematically represent consonant phonemes iconically depict the place of articulation of these phonemes (cf. Figure 26). However, this visual feature that is diagrammatically (cf. Section 3.3.1.2) shared by graphematically related basic shapes (such as |ㄱ|,|ㅋ| and |ㄲ| which are all used for graphemes that represent velar phonemes) can neither be extracted nor does it consistently represent a linguistic 'unit', but instead only a linguistic feature, specifically a phonological feature. As such, it could be compared to the subsegmental components in Chinese that contribute graphematic information to the overall grapheme but are not independent graphemes themselves.

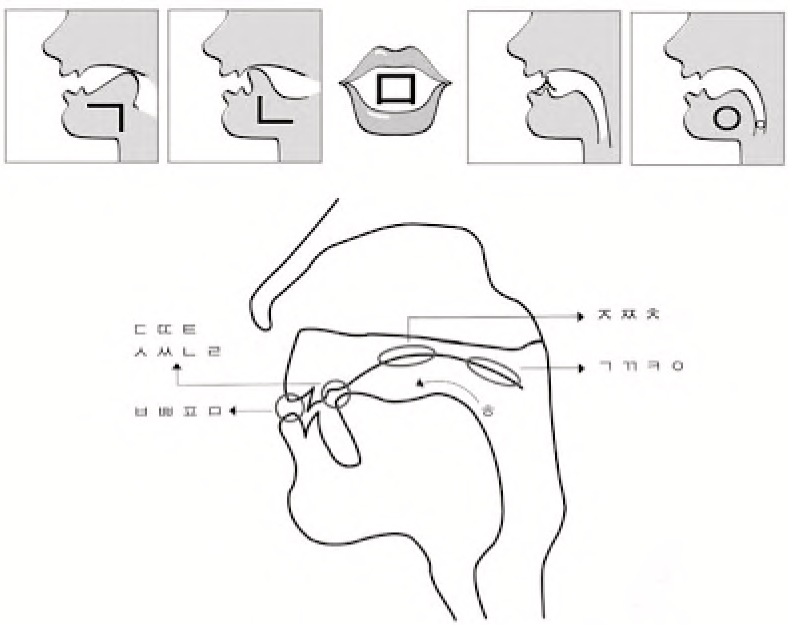

Figure 26: The featural level in Korean Hangul, from: http://4.bp.blogspot.com/-rgIZ4WHhv2o/VgNQhffUypI/AAAAAAAAMlI/5yLODu3qxlw/s400/consonant_1.jpg (February 11th, 2019)

Interestingly, above the grapheme level, which represents different linguistic levels in different writing systems, the next level that consistently produces visually salient written units is a relatively high level: syntax. Syntactic units such as clauses, phrases, and sentences (however they might be defined in a given context) are consistently marked by empty spaces and/or punctuation in the writing systems of the world, as are various "units" at an even higher linguistic level, the textual level, which one might also call the discursive level.

This typology sums up the findings of this introductory and descriptive theoretical grapholinguistics chapter and thus represents merely a rough working typology that serves as a backdrop for the next chapter, in which various writing systems will be evaluated within a naturalist framework.

2.4 Epilogue: Graphematics is dependent on phonology (sometimes)

> An autonomous graphematic analysis – in fact an oxymoron – can only be undertaken tentatively and provisionally. In this case one acts as if graphematic words, syllables, or letters can be decomposed into their material features and analyzed in their own right without having recognized them as meaningful units of a language and subjected them to this general point of view. If these relationships are kept in mind, however, this at least avoids the risk of positivist reductionism. Graphematic analysis is constitutively possible only as a *relatively* autonomous analysis. (Schmidt 2018: 47, my translation)[260]

After the modules of writing systems – their structure, systematics, and units – were described and discussed extensively in the preceding sections, I want to return to the question asked in the prologue and give the following (still preliminary) answer: graphematics is dependent on phonology, at least sometimes.

As Schmidt states in the opening quote above, "autonomous graphematic analysis" is actually an oxymoron, as graphematics treats the linguistic functions of writing systems, the links between the visual and the linguistic. As he accurately observes, in a graphematic analysis, it is not possible to evaluate units such as the "graphematic syllable" or the "graphematic word" without previously having identified them as units of a given language. They are such units of a given language precisely *because* their visual substance is linked to levels such as the phonologically syllabic level or the morphological level of a language. /haʊs/ and <house> are not two different words of different language systems, but units of different modalities. <house>, as a written word, does not refer to an extralinguistic referent (a specific existing house, for example), but to a linguistic structure. While it can be analyzed independently, this written word does not represent linguistic structure independently of the phonological presentation /haʊs/. Similarly, <木> *mù* 'tree' is connected to the signatum of the Chinese morpheme for {tree} which has as its phonological representation /mù/. The Chinese grapheme, and in general, the Chinese writing system, are not independent of the morphological system of Chinese.[261] It is a visually linguistic system (which is a nice paraphrase for "writing system") that represents the Chinese language. The English writing system and its units represent the phonological level, but not exclusively. Other principles are at work as well, and morphological, lexical, etymological, etc. information can be and is represented at the expense of phonological transparency. However opaque an alphabet becomes, in sum, it is still phonographic, which is where the ominous attribute *relative* comes into play.

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[260] „Eine autonome graphematische Analyse – eigentlich ein Oxymoron – kann nur versuchsweise und vorläufig vorgenommen werden. Man tut dann so, als könnte man graphematische Wörter, Silben oder Buchstaben in ihre materiellen Eigenschaften zerlegen und an und für sich betrachten, ohne sie je schon als sinnvolle Einheiten einer Sprache erkannt und damit diesem allgemeinen Gesichtspunkt unterworfen zu haben. Bleiben aber diese Zusammenhänge im Blick, ist zumindest die Gefahr eines positivistischen Reduktionismus gebannt. Die graphematische Analyse ist konstitutiv nur als *relativ* autonome Analyse möglich" (emphasis in original).

[261] However, they are independent of the phonological level, which is why the claim "graphematics is dependent on phonology" is only true sometimes. In this case, graphematics is dependent on morphology. In any case, in each writing system, there is a primary dependence on a specific linguistic level.

As I argued in the prologue to this chapter, a lot of what makes writing unique in comparison with speech is its materiality, which is studied by graphetics. Graphetics, by way of its definition, is completely independent of language.[262] This supersedes a lot of what has been termed "intra-graphematic analysis", at least the part that relied on the materiality of writing. Graphematics, especially if it is – from a methodological point of view – assumed in analogy with phonology, does not have at its disposal the necessary tools to adequately study the materiality of writing (cf. Wehde 2000: 48). As the discussion about the graphematic syllable proved, assuming "graphematic" units based on material features leads to writing system- or script-specific categories that are of no or only little value for a more universal grapholinguistic theory and specifically for comparisons of writing systems. It also puts too much weight on the seemingly autonomous graphematic features of such a unit: yes, there are points at which the graphematic syllable in German deviates from the phonological syllable, but the correspondences between these two types of units are much more obvious. The same goes for the controversial definition of the grapheme: the way it has been autonomously defined in German grapholinguistics, it is a minimal lexical contrast in writing that is analogous to minimal lexical contrasts in phonology. This definition only holds for segmental writing systems in which this function of being minimally lexically distinctive can be interpreted as parallel in writing and speech. The meaningfulness of such a definition suffers severely from an extension to other writing systems. Graphemes are not minimal lexical contrasts that happen to correspond to phonemes. Graphemes are written units that *represent* phonemes (or syllables, morphemes, ...). Sometimes, for a variety of reasons, be they historical, political, etc., they do not do so straightforwardly. If the graphematic solution space of a writing system is large, the writing system *will* develop its own strategies of dealing with ambiguities. Some systematic (i.e. internally determined) graphotactic restraints, thus, will *not* be explainable with recourse to other linguistic levels, but instead only in a truly intra-graphematic analysis.[263] Orthographically determined spellings, which are regulated externally, are also often not explainable through other linguistic levels. Writing, thus, *is* undeniably relatively autonomous, whether through its graphetics or its intra-graphematic systematics or its orthographic regulation. However, in my view, this autonomy *follows* dependence. In the phonology-autonomous hypothesis, writing is initially seen as an autonomous system and *then* correspondences (or, put differently: dependencies) between writing and other linguistic levels are established and studied. In my view, it is vice versa: writing is *dependent* on language since writing represents language, but in the next step, it has developed autonomous features that imperatively need to be studied independently.

Methodologically, thus, I agree with and would proceed exactly the same way adherents of the autonomous way do, with the exception of the sequence of steps and that I would outsource a lot of what falls under their "autonomous analysis" to the subdiscipline of graphetics instead of dealing with it as though it were a genuinely graphematic matter. In the next step, *theoretically*, I would not interpret the ensuing results of a graphematic analysis the same way they might. Writing is not autonomous from language, and that includes speech as the structurally primary modality and, in turn, phonology as an abstract level involved in speech (cf. Figure 27). However, for this methodological *choice* of treating writing as its own system and striving to uncover its distinct features, the view that writing is structurally independent of speech does not need to be axiomatic. The absolute rejection of any claims of dependence, I argue, stems at least partially from the fear of degrading writing as something unworthy of linguistic study, which it is not. The distinct features of writing, however, can still be uncov-

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262 With the exception that graphetics is defined as the study of the materiality of writing, and what writing is vs. what drawing is, for example, can only be evaluated when writing is defined graphematically as the representation of language. Thus, graphetics is dependent on a *definition of writing* and as such, is also a linguistic discipline, but methodologically, it does not study the representational function of writing and is independent of it.

263 Cf. also Handel (2013: 24) with respect to the Chinese writing system, although this holds for all writing systems: "[...] some internal elements can only be understood in purely graphic terms as units of a structured system that is independent of the spoken language".

ered even if one accepts that the graphematic level is always dependent on the other levels of language which it represents.

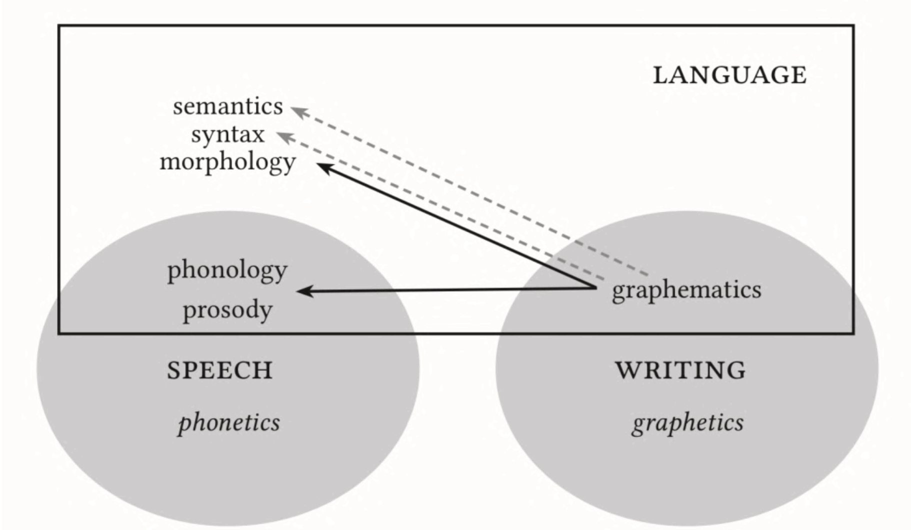

Figure 27: Conception of the relationship between speech and writing

On the surface, my analysis might not differ considerably from the autonomists'. Underneath, however, it is fundamentally different. It was necessary to establish this difference as extensively as it was done here since it proves central for a comparative grapholinguistics that completely opens its doors to an integration of non-alphabetic writing systems.

2.5 Summary

Grapholinguistics is a fairly young and not yet fully established and accepted subbranch of linguistics that studies all aspects of writing. It is interdisciplinary in nature, as it bundles questions about writing that come not only from linguistics, but also other disciplines such as cognitive science, biology, art history, philosophy, pedagogy, etc. Its cornerstone, however, is certainly linguistics, as writing is defined as the graphic representation of *language*. This includes, aside from visual writing, also tactile writing such as braille. In this thesis, however, the focus is on visual writing. Grapholinguistics had a rough and slow start particularly because in some of the most dominant paradigms of 20th and 21st century linguistics, writing was devalued as secondary or even just "parasitic" to speech. Accordingly, it was not regarded as a system in its own right that needed to be studied, and spoken language was treated as the only worthy object of linguistic study instead. Aside from a number of important philological, historically-oriented works on writing stemming from the Angloamerican academic culture, it was the German linguistic community that advanced the establishment of a grapholinguistic theory and of a discipline *Schriftlinguistik*, a designation that first appeared in an edited volume and was later cemented as the discipline's name when it became the title of a prominent textbook (now in its fourth edition: Dürscheid 2016). While in all grapholinguistic communities around the world and in all of the discipline's subbranches, myriad theoretical and applied advances were made, a desideratum that remains to this day is an overarching theoretical framework that bridges the divide between writing systems that are typologically diverse and that, for this reason, have not been compared before. This is where the present thesis comes into play.

The overall structure of all writing systems has been modeled by Neef (2005, 2015). I follow his lead and define writing systems as multimodular phenomena with a language system, graphetics, and graphematics as obligatory modules, and orthography as an optional module. Each of these modules, except language, which is the subject of linguistics in general, is studied by its own subdiscipline of theoretical grapholinguistics: the graphetic module is studied by graphetics, the graphematic module by graphematics, and the orthographic module by orthography research.

Graphetics, as the least developed grapholinguistic subdiscipline, is concerned with all aspects of the materiality of writing – the visual form of writing itself, but also the surface on which it appears as well as the instruments with which it is produced. At its center is the study of scripts, inventories of visual basic shapes that are used for writing but can also be used for other notational purposes such as mathematical notation, for example. Analogously to the division of phonetic subdisciplines and a simplified threefold model of communication, graphetics is divided into three subbranches: (1) *Productional graphetics* studies the productional aspects of writing, including, at the lowest level, motor processes in handwriting or typing, and at a higher level, questions regarding the design choices involved in the material composition of texts (e.g. why did the text producer choose a specific typeface?). (2) *Script-graphetics* or *descriptive graphetics* treats the visual or tactile aspects of writing in a descriptive way. It studies how scripts and their basic shapes are structured. At the center of these descriptions is writing's constitutive feature of spatiality, its expansion in space, i.e. on a writing surface. Finally, (3) in *perceptual graphetics*, similar to productional graphetics, the focus is on cognitive and neuropsychological questions, such as how writing is perceived and recognized. Sociolinguistically, or more adequately, sociosemiotically, the questions of what the materiality of a given product of writing reveals about the producer as well as why it is perceived in a certain way by the recipient are central.

Script-graphetically, the writing surface can be subdivided into four spaces that are constituted by empty spaces, i.e. spaces not filled with writing. There are different types of these empty spaces: the first-order empty space occurs between single basic shapes (= segments) and, thus, makes visible the *segmental space*. A sequence of concatenated segmental spaces constitutes the *linear space* – in this very paragraph, a line is a linear space. This linear space is prototypically filled with 'words': in graphetic terms, these are sequences of segmental spaces divided by second-order empty spaces or so-called *one-dimensional graphetic sequences*. If lines are concatenated (vertically, as in this paragraph), the result is a 'paragraph', or, neutrally phrased, a *two-dimensional graphetic sequence*, other instances of which are columns, footnotes, etc. These sequences occupy *areal spaces*. Finally, if areal spaces are arranged (or 'layouted') on a larger surface, the result is a *holistic space* such as the page on which this text is printed. This so-called cartography of the writing surface allows for a subdivision of script-graphetics into *micrographetics* (studying the segmental space), *mesographetics* (studying the linear space), and *macrographetics* (studying the areal and holistic spaces). Additionally, *paragraphetics* deals with the third dimension complete with other aspects of the materiality of writing such as the texture of the surface and other haptic features.

The central graphetic unit is the basic shape. It is an abstract visual unit and, as such, the 'skeleton' of all the concrete graphs that materialize it. The description of a basic shape such as |A| includes information on the number of *elementary forms*, i.e. segments that it is composed of, as well as their topological configuration and their spatial arrangement within the segmental space. The *graphetic solution space* allows for variation within one basic shape, which explains the richness of visual variation in different handwritings or typefaces. The borders of the graphetic solution space are not graphetic, but conventional and graphematic in nature: whereas in one script, a given graphetic solution space might be larger (as for |T| in Roman script), in a different script, it might be smaller (as for |T| in Greek script), since straying too much from its visual appearance potentially invokes a different basic shape (such as |Γ|) which can either be graphematically "meaningless" since it is not an actual unit of the script but which might also be the part of a different graphematic relation (as in <Γ> which is a different grapheme than <T> in the Greek writing system). The number of the elementary forms as well as their topological configuration is most important for the stable identity of a basic shape: the difference between |T| and |Γ|, one might argue, is only the position of the horizontal stroke on top of the vertical stroke.

Graphematics is the second and central subbranch of grapholinguistics. It deals with the link between the visual units that are studied by graphetics and units of language. The smallest of these links is the *grapheme*. Due to the multiplicity of different definitions that circulate in the literature, it is an infamous concept and term, and no binding definition exists for it, at least not one that can be reasonably applied to typologically diverse writing systems. My proposal for a universal grapheme definition is dependent on three criteria: a grapheme must (1) differentiate meaning, (2) represent a linguistic unit, and (3) be minimal. These criteria allow for the identification of graphemes not only in segmental writing systems such as alphabets but also in syllabaries or morphographic systems. A broader conceptualization of the grapheme also opens up the possibility of comparing the minimal functional units of different writing systems.

As writing systems are structurally and compositionally complex, graphemes combine to form larger graphematic units. These have been postulated and described mostly in the context of German grapholinguistics, so their definitions are based in and on alphabets. Also, as they stem from the wish of an autonomous graphematics, they are commonly defined with recourse to features of writing alone. This led to reliance on graphetic criteria, which, in turn, results in the fact that these larger "graphematic" (or graphetic?) units are not straightforwardly transferable to other writing systems. The *graphematic syllable*, for example, is defined visually by an alternation between visually more and less salient units. However, in systems other than segmental writing systems, no visually discernable graphematic syllable that adheres to this definition can be made out. Similarly, the definition of the *graphematic word* depends on what I called the second-order empty space. In writing systems without spaces between words, such as Chinese, Thai, or Japanese, these empty spaces visualize larger linguistic units such as syntactic units. Finally, the *graphematic sentence* as the largest graphematic unit discussed in the literature is constituted not only by spaces but also by punctuation, a phenomenon that tends to be universal in the writing systems of the world. What is striking in the context of the other graphematic units is that the graphematic sentence appears to be a truly inherently written unit. As such, it influences other (e.g. syntactic) definitions of the sentence and not vice versa.

Through the discussion of these graphematic units, it becomes evident that the lack of separation of graphetics and graphematics leads to conceptual confusion. Keeping them separated, on the other hand, allows for a more organized definition of phenomena such as allography and graphotactics.

Orthography is the final module of writing systems. Unlike the other modules, it is optional. It is the external standardization and (double) codification of the system, its *norm*. As such, it overlaps with the system (= *graphematics*) and the use of the system, but not completely. The part of orthography that overlaps with the system is called *systematic orthography*. The entities in charge of standardization are so-called *language regulators* – language academies, councils, branches in ministries for education, culture, etc. For them, orthography is commonly one of the central concerns of language policy. The aspects of a writing system that are subject to orthographic regulation vary from system to system. Most commonly, those aspects of writing systems tend to be standardized in which there is a large degree of variation. *Principle* and *rule* are two central orthographic concepts: principles are abstract generalizations of general rules, and thus themselves rules of the highest order, so-called *hyperrules*. The maxim 'write as you speak!',[264] for example, can be regarded as such a principle. Principles subsume *general rules*, that is, rules whose scope ranges over a significant number of words or contexts, whereas *singular rules* concern isolated words and their spellings. The former are codified in regulative guidelines, the latter in (orthographic) dictionaries. It is paramount to carefully distinguish between *rules* and the *explication of rules*. Also, from the perspective of the system, what needs to be distinguished is *given rules* as a part of systematic orthography, which correspond with graphematic regularities in the system and originated in usage, and *set rules* – rules that are not accounted for in the system and are, thus, part of unsystematic orthography. From the perspec-

[264] German ‚Schreib, wie du sprichst!' (cf. Mattes 2015).

tive of the user, there exist internal norms and external norms. *Internal norms* do not necessarily conform to the *external codified norms*, but there is a complex interaction between the two: external norms can be, and commonly are, internalized, while internal norms can become the basis for external norms. Orthography is a linguistic resource and is perceived as common property. Therefore, various stakeholders claim ownership and the right to co-determination: academics, politics, religious authorities, the media, the public, etc. Together with their respective motivations, they create complex discourses that surround orthography as a sociolinguistic phenomenon.

Whereas there exist a number of proposed typologies for writing systems, there is no typology of scripts yet. As scripts are graphetic objects, a script typology must be informed by their materiality, primarily visually. Various visual features are qualified to become the deciding criterion for a script typology. From a descriptive point of view, however, choosing one of them is arbitrary. Is a script typology based on visual density (i.e. the average number of elementary forms of a basic shape and their extension in the segmental space) more reasonable than a script typology based on the size of a script (i.e. the number of basic shapes) or the angularity/roundness of the basic shapes of a script? I provided no answer to this question as I argued that descriptively, there cannot be a "right" answer. Chapter 3 will investigate which of the visual features are of relevance in processing – productively and perceptually, that is – and this information can potentially be taken into account for the choice of a base feature in a prospective script typology. When descriptively, there is more than one answer, why not make a choice based on processing?

The base feature for most of the proposed *writing system typologies* is the type of linguistic unit that the smallest written units, the graphemes, represent. Accordingly, next to the often made distinction between *writing* and *non-writing*, made with different terms such as semasiography vs. glottography, embryo writing vs. writing or partial writing vs. full writing, the most relevant typological distinction is between *phonography* and *morphography*. Following Gnanadesikan (2017), I gave an overview of how the most important assumed types of writing systems visualize different linguistic units at various levels and combined this with the graphetic cartography of the writing surface to highlight how graphetics and graphematics interact cross-grapholinguistically. Similar to a potential script typology, this typology of writing systems is descriptive and preliminary, as again, I argue that only insight into the processing of writing systems will disclose which features of writing systems are not only descriptively reasonable base features for a typology, but also from a processing perspective.

One of the fundamental questions that are not only relevant for a theoretical grapholinguistics but also for linguistics in general concerns the exact relationship between writing and speech. Is writing dependent on speech? As I argued, there are problems inherent even in the formulation of this question. Writing has myriad features that are not dependent on speech (and vice versa), and many, though not all, of these distinct features stem from the materiality of writing that is utterly different from the materiality of speech. The abstract systems that underlie both of them, respectively, graphematics and phonology, are in a relationship of dependence, however, at least in phonographic writing systems. As an extension of the autonomous methodology, specifically the analogical view of defining the grapheme, to other non-segmental and non-phonographic writing systems proved, a view that treats graphemes as independent of phonemes structurally is an alphabetocentric view and falters in a more universal perspective. It is, for example, difficult to conceptualize the Japanese writing system without acknowledging that the *kana* inventories represent to (and are not just parallel to) syllables, or to describe the Chinese writing system without acknowledging that the *hanzi* represent morphemes. This implies neither that everything in writing can be explained through writing's function of representing various levels of language, nor does it mean that writing is not its own object of linguistic study. It means merely that as an abstract system and as a sublevel of every language that has a writing system, graphematics is dependent on other linguistic subsystems such as phonology or morphology. This is only logical since graphematics was defined as the module that links graphetic units with linguistic units, and as such, is obviously dependent on these linguistic units. Many of the distinct features of writing are not even primarily the subject of graphematics, but of graphetics. And unlike graphematics, graphetics *is* independent of language. Crucially, it bears repeating that the fact that graphematics is structurally not autonomous does not mean that methodologically, it cannot and should not be studied autonomously. It is true, after all, that some features of writing can only be uncovered if writing is studied – at least in a first step – independently.

This chapter serves as a descriptive basis for the following chapter. In describing the structure of writing systems and their modules in detail and exposing the relevant units of all levels to a more universal perspective, it offers the backdrop against which the next chapter will evaluate, at first, the systematic and linguistic fits of scripts and writing systems as well as their processing and sociocultural fits. The study of these aspects of grapholinguistic naturalness will hopefully reveal relevant categories for the evaluation and comparison of writing systems. In the course of this analysis, some of the descriptive, theoretical findings of the present chapter might also demand a revision.

3 Natural Grapholinguistics

> Not all written structures are disseminated equally in natural languages; not all reading and writing processes and structures in writing are learned at the same time by children; not all written structures are similarly affected by the change of writing systems; not all written structures are equally easily decoded. Notions of this sort have long been current; their meaning, however, is unclear and controversial.

The first two chapters of this thesis have dealt with the central tenets of Naturalness Theory and with the foundation of grapholinguistics, respectively. While Naturalness Theory aims to *explain* the existence and persistence of linguistic structures, the structuralist presentation of grapholinguistics so far concentrated largely on *describing* the structure of writing systems, which it did in a rather atheoretical vacuum. This chapter, as the heart of the present thesis, will now attempt to link the two. The aim of embedding writing in a naturalist framework is to explain why the observable structures exist and have prevailed in writing, or, as Watt (1994a: ix) phrased it, "why writing-systems are as they are". The introductory quote given above mirrors Mayerthaler's famous quote as cited in the section on Natural Morphology (NM, cf. Section 1.3). It shows that the premises which led to the development of NM can be directly transferred to phenomena of writing. Like language, writing is formed by human capabilities and needs, so the features of writing must meet the physiological, cognitive, and social requirements of humans. Consequently, they "are conditioned by the mind and the hand [and the eye, D.M.] and the nature of writing materials" (Watt 1994a: ix). These remarks alone strongly insinuate that Naturalness Theory is a fitting theoretical framework for explaining the nature of writing. The approaches formulated in this framework offer intriguing possibilities when their central concepts are transferred to the subject of writing. This will be proved in the present chapter.

Natural Phonology (NP) is built on the premise that human physical limitations constrain the material outputs in speech and, consequently, the material stimuli that are capable of serving as the functionally distinctive units of speech and language in general: phonemes. The core of this idea can be taken over directly to the realm of writing in a proposed Natural Graphetics. However, for the production and perception of speech, no tools other than inalienable body parts such as lungs, tongue, lips, ears, etc. are needed, whereas we do need additional tools and materials for writing: a writing surface and a writing instrument. The constraints that these external circumstances put on the production and perception processes of writing differ in significant ways from the ones put on speech. How we use pens to handwrite, or keyboards, touchscreens etc. to type affects the way we write: how fluent the writing process is and how the written product will look, among other things. From a different perspective, whether a pencil or a pen was used or whether something was written on matt or glossy paper or even on a screen might also influence how the written product is perceived. This means that aside from the tools used for writing, the two-dimensional writing surface is also of relevance. Thus, whereas for speech, human physiology plays the crucial part in explanation, for writing, we additionally need to consider the writing surface and writing tools. These three variables interact crucially and affect the natural processes that are part of writing and reading processes – in other words, natural processes that exist to overcome hurdles caused by human physiology, tools, and the surface.

Natural Morphology (NM) is based on the idea that the semiotic structure of linguistic signs has a bearing on how they are cognitively processed by humans. This idea can be taken over directly to writing in the form of Natural Graphematics. Graphemes and larger graphematic relations (such as graphematic words, graphematic sentences, etc.) are conceived of as signs: the visual units are the *signantia*, the linguistic units they represent the *signata*. Humans are interpreters who drive semiosis, i.e. constitute the semiotic relationship between the visual and the linguistic. How straightforwardly graphemes are structured in a grapheme inventory, e.g. whether the visual basic shapes consistently represent only one linguistic unit each and vice versa, is of crucial relevance. Since writing systems represent languages, i.e. primary semiotic systems, they are secondary semiotic systems, meaning the parameters of NM are transferred to a secondary level. Thus, the analysis of the naturalness of writing is not interested in the naturalness of the referents of written units, e.g. phonemes in alphabets or morphemes in a morphographic system such as Chinese, but instead with the naturalness of how these units are represented graphematically in writing. Whereas a morpheme is a sign, a grapheme that represents a morpheme is a sign of a sign. It is the naturalness of these graphemes as secondary signs that is assessed in Natural Graphematics as well as the repercussions that the semiotic relations have on the processing of these signs in reading and writing. Since writing, unlike language, is a secondary semiotic system, we cannot only ask whether writing fits our human processing needs, but also how well it fits the primary semiotic system that it represents: language, and in particular the specific language systems that different writing systems are based on. This makes possible a distinction between a *linguistic fit* and a *processing fit* of writing systems which echoes the distinction between phenomenological naturalness and processing naturalness (cf. Section 1.1).

The visual materiality of writing asks for a systematic examination of scripts, defined as inventories of visual basic shapes that are employed for writing systems. These basic shapes and their relationships within a system can be fruitfully analyzed from a systems-oriented perspective: for example, whether the basic shapes |R| and |K| both conform to the set of visual features characteristic of the uppercase basic shapes of the Roman script, the most salient of which is that they are oriented in the writing direction (dextrograde), is a question assessed by the systematic fit of the script. In the next step, a possible question is whether the systematic fit is functionalized linguistically, i.e. whether a given visual feature consistently represents one linguistic feature. Whether |a| and |o|, which are most frequently used to represent vowels as in the vowel graphemes <a> and <o>, both systematically lack ascenders or descenders precisely *because* they are used for vowel as opposed to consonant graphemes is a possible question of this linguistic functionalization of the systematic fit of scripts. How the increase of visual material and complexity in basic shapes of the Chinese script such as |木| and |森| reflects the conceptual increase in their referents, the switch from singular <木> *mù* 'tree' to plural <森> *sēn* 'woods', is another question located at the graphetics-graphematics interface. Whereas in NP, phonemes were not assessed semiotically as they are not signs, and this kind of iconic or diagrammatic relationship is also found rather seldom in the constituents of morphemes (except for phenomena such as onomatopoeia, reduplication, etc.), there exist myriad interesting ways in which the semiotic interaction between the visual and the linguistic can be investigated in writing. In a first step, an analysis needs to proceed on a descriptive basis, and then, in a next step, the question can be asked whether the described semiotic relations have a bearing on cognitive processing.

Writing is its own abstract semiotic system with its own type of materialization. As Treiman & Kessler (2014: 104) put it: "Writing has a double face. It is an object in itself – marks on a surface – and it is a representation of something other than itself – a linguistic structure". Graphemes as signs are abstract units of writing, but the basic shapes that materialize them are also considered units of writing. This means that both the semiotic foundation and the rather static analysis of linguistic structures established in NM and the physiological foundation and the dynamic analysis of the processes involved in producing and perceiving linguistic structures can be applied to writing. In other words, while the subbranches of Naturalness Theory were decidedly distinct in their approaches, as NP was based on the materiality of speech and NM focused on the semiotic structure of the morphological subsystem of language, both of these aspects can prove complementary in an investigation of writing. Whereas in traditional Naturalness Theory, at least some scholars regarded NP and NM as completely separate branches studying separate phenomena, in Natural Grapholinguistics, their foundations can be logically merged to investigate the subject of writing. This is an overwhelming indication not only of the fact that Naturalness Theory is indeed a coherent theory and its subbranches are tightly connected, but it also underlines that Naturalness Theory as a theoretical framework and writing as a subject make an astonishingly good match.

However, writing is different from speech in many more crucial ways than traditional Naturalness Theory was equipped to deal with. Writing, as a human invention, is deeply entrenched in culture, society, and politics. Writing systems are not only linguistic systems but cultural systems that are determined by various extralinguistic factors. They are "public goods that are subject to cultural attachments and political decisions" (Coulmas 2009: 15). To give an example: when a writing system is devised for a yet unwritten language, the members of the linguistic community in question may turn down a perfect linguistic fit, i.e. the semiotically most natural relations between basic shapes and linguistic units (such as phonemes) simply because they want some of the basic shapes they use – very often, these come from Roman script – to have the same graphematic values they have in the writing system of a dominant language, e.g. their typical graphematic values in the French or English writing systems (cf. Hinton 2014). In the described case, sociocultural forces override genuinely linguistic aspects. Since writing is permanent while speech is fleeting, aspects such as correctness play a more crucial role for writing than for speech: while most speakers are oblivious to *orthoepy* (correct pronunciation), *orthography* (correct spelling) is of utmost importance for a majority of users in literate communities. External codifications determine what is "correct", and writing that deviates from these norms is marked – whether as wrong, dialectal, slang, etc. Furthermore, using deviant forms of writing not only often carries social meaning – inviting assumptions about a writer's level of education, class, age, gender, etc. – but it is also not seldom sanctioned socially. Orthographic norms might not exactly be laws that one *must* obey, but some users certainly treat them as if they were. These are just some of the different facets of the social nature of writing that must imperatively be included in a comprehensive investigation of the naturalness of writing.

The present chapter aims not to merely transfer existing ideas of Naturalness Theory to the subject of writing, but to investigate how the concept of naturalness can be meaningfully extended to account for features of a secondary and deeply cultural semiotic system that are not pertinent in the naturalist study of language. This results not only in a novel treatment of writing in a suitable theoretical framework but simultaneously also in the reassessment of said theoretical framework. After all, this thesis is not only a study of writing but also a study of naturalness.

First, I will attempt to prove that Naturalness Theory provides a fitting theoretical framework for the explanation of the structures of writing (3.1 Prolegomena). In the past, writing systems have frequently been qualitatively evaluated and compared, with some of them alleged to be "better" than others. I will discuss the criteria that have played a role in these evaluations and assign them to three categories that will structure the further investigation of naturalness: the (1) *systematic* and *linguistic fits*, i.e. whether a script is inherently structured naturally and whether a writing system fits the language it represents semiotically, the (2) *processing fit*, i.e. how the features of scripts and writing systems affect physiological and cognitive processing, and the (3) *sociocultural fit* which assesses whether a script or writing system suits the social and cultural needs in a given linguistic community. Taken together, these three fits are highly indicative of the naturalness of certain features of scripts and writing systems.

In the next step, the naturalness of scripts will be evaluated (3.2 Natural Graphetics). Features of scripts will be discussed with respect to their systematic, processing, and sociocultural fits. Various examples will illustrate which features play a crucial role in graphetic naturalness. These are the naturalness parameters of a Natural Graphetics. Analogously, the naturalness of the graphematic module and writing systems as semiotic systems in general will be assessed (3.3 Natural Graphematics). Again, examples will showcase how the graphematic modules of given writing systems fit the languages they represent, how they cater to our cognitive needs, and what sociocultural considerations are of importance. Lastly, I will sketch how the naturalness of orthography could be conceptionalized (3.4 Natural Orthography). With these thoughts on a Natural Orthography, I will enter entirely uncharted territory, since what is discussed here are not linguistic or semiotic structures, but norms and rules superimposed on these structures. The main question will be how these rules can potentially be used to compensate any unnaturalness resulting from the graphetic and graphematic modules, and how authorities deciding on these rules can act *naturally*, so to speak, in order to make sure an orthography is a useful and natural complement to a writing system and not an obstacle that unnecessarily complicates it. An extensive summary and discussion (3.5 Summary and discussion) will collect the main findings of the chapter, evaluate them, compare them, and put them into context: what do the findings mean for Naturalness Theory, what do they mean for grapholinguistics? What is the core of a Natural Grapholinguistics? And how can the results be applied practically (e.g. in typeface design or the choice of script used for literacy acquisition in schools, in decisions in the context of orthography reforms, etc.)?

3.1 Prolegomena

3.1.1 Evaluation of scripts and writing systems[265]

> I have taken it as given that some writing systems are better than others. This could certainly be debated. (Rogers 1995: 31)

The idea of an "optimal" writing system is not new. Indeed, many publications have painted a picture of such an optimal writing system based on a variety of criteria and/or features. This practice is most evident in guidelines that describe how new writing systems should be devised. In *Advances in the creation and revision of writing systems* (Fishman 1977), for example, one contribution is titled *Principles for the design of practical writing systems* (Venezky 1977), a title that captures that, for several decades, writing systems have been qualitatively evaluated based on criteria, or, in this case, "principles". Titles of other works that are indicative of this are *The ideal orthography* (Bauernschmidt 1980), *Factors in designing effective orthographies for unwritten languages* (Cahill & Karan 2008), *In search of the perfect orthography* (Venezky 2004), or *Optimal orthographies* (Rogers 1995). The criteria or principles listed in these works, as plausible as they appear, were, for the most part, postulated intuitively. There is nothing inherently wrong with such a fundamentally inductive approach, and the proposed criteria are by no means irrelevant, but in the search for natural features in writing systems that is embedded in the theoretical framework of Naturalness Theory, criteria cannot simply be appointed without an explanation of their underlying foundations as well as external evidence supporting them.

Aside from these evaluations of writing systems, there also exists mere and blatant ethnocentrism, specifically Eurocentrism, which culminates in the view that the alphabet is the most ingenious invention of Western civilization (cf. the *Alphabet Effect*, Logan 2004, and a criticism thereof in Grosswiler 2004; cf. also Olson 1996: 8f.). In this view, the alphabet is sharply distinguished from the rest of the possible types of writing systems such as syllabaries or morphographic writing systems, which is most evident in extreme statements such as "it is generally accepted on all grounds an alphabetic system is the best" (Berry 1958: 753). For a more recent statement in this vein cf. Jones & Mooney (2017: 13), who write "[o]verall, it is argued that morphographic systems are inferior to phonographic ones". This alleged "superiority of the alphabet" (Barton 1995: 20) and the simultaneous depreciation of writing systems such as Chinese and Japanese (cf., for example, Hannas 1997) have had major repercussions for linguistics and grapholinguistics: not only was the development of writing modeled in an evolutionary framework that propagated a teleological development in stages from pictographic writing to the final and optimal end stage of alphabetic writing (Gelb's infamous and refuted *Principle of Uniform Development*, cf. Gelb 1969: 201; for a criticism, cf. Mattingly 1985; Miya-

[265] Parts of Section 3.1.1 have appeared in Meletis (2018).

moto 2007), but the alleged superiority of the alphabet ultimately also resulted in what Share (2014) calls an "alphabetism" that pervaded and to this day largely infiltrates interdisciplinary grapholinguistic research. This includes not only the modeling of reading and writing but also descriptive grapholinguistic theorizing and models in general.

Table 6 collects some of the criteria of optimal scripts and/or writing systems that have been mentioned in the grapholinguistic literature.[266] Most of them will be discussed in the following subchapters. Although at first glance, these lists appear diverse and unsystematic, the criteria can be assigned to three categories that each cover a certain aspect of how well a script or writing system meet certain requirements: 1a) the *systematic* and 1b) *linguistic fits*, 2) the *processing fit*, and 3) the *sociocultural fit*. Broadly put, the systematic and linguistic fits are evaluated descriptively and semiotically, the processing fit psycholinguistically, and the sociocultural fit sociolinguistically. Interestingly, these three fits overlap with what is also embedded as (extra)linguistic foundation in the comprehensive definition of naturalness within Naturalness Theory, namely physiology, semiotics, cognition, sociopragmatics, and they roughly correspond with categories assumed in a number of grapholinguistic works (such as Venezky 1977; Rogers 1995).

The first type of fit is descriptive, and it differs for scripts and writing systems: only the visual features of basic shapes and their systematicity within a script are of concern for the 1a) *systematic fit* of scripts. The question here is not whether scripts fit a given language, but whether scripts, as visual systems, are coherent. This includes questions such as: How systematic are the relationships between the basic shapes of a script? Are the visual features consistent throughout the script or are there outliers such as |J| in Roman script in which almost all other uppercase basic shapes are oriented rightwards? Are there any systematic gaps, i.e. basic shapes that would be well-formed according to the features of the script but that do not actually exist in the script?

The 1b) *linguistic fit* of writing systems, more precisely of their graphematic modules, describes the nature of the relationship between a language and its writing system. In other words: how well a writing system fits a language linguistically. The semiotic quality of the graphematic module is evaluated, the link between the visual and the linguistic (cf. Baroni 2011). While universal preferences can certainly be determined for an "optimal" linguistic fit of a writing system, the linguistic fits of given writing systems must be evaluated individually, as the interaction between a specific language system and its writing system is subject to system-specific factors (cf. the subtheories of naturalness below).

The linguistic fit is the subject of most grapholinguistic publications, as they describe how units of writing correspond with linguistic units, relations which are often termed *grapheme-phoneme-correspondences* in the case of segmentally phonographic systems. As these correspondences are a semiotic matter, the semiotic naturalness parameters of NM (cf. Section 1.3.2) are expected to be fruitful for the evaluation of the linguistic fit. Indeed, a number of writing systems have already been evaluated with respect to two of those naturalness parameters: transparency and uniformity. A grapheme is *transparent* if its basic shape corresponds with only one linguistic unit, the latter being a phoneme, a syllable, a morpheme, or a different type of linguistic unit.[267] The German grapheme <v>, for example, is not transparent since the shape |v| is used for both /f/ as in <viel> 'much' and /v/ as in <vage> 'vague'. Inversely, a linguistic unit is *uniformly* represented if there is only one basic shape associated with it. This does not hold for German /f/ which can be written as |f|, |v|, and a combination of |p| and |h|, <ph> (cf. Nerius 2007; for an elaborate analysis of the graphematic solution space of /f/, see Balestra, Appelt & Neef 2014; cf. also Section 2.2.2.2). A grapheme is biunique if the relation between the

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[266] Some criteria concern scripts, some writing systems, and some both. This once again highlights the fact that these notions are frequently not kept apart in the literature.

[267] Many writing systems are not purely of one type (e.g., alphabetic, morphographic, and so on) and different graphemes within the same system can represent units of different linguistic levels.

basic shape and the linguistic unit is both transparent and uniform (cf. Munske 1994: 19f.). Complete biuniqueness can be evidenced, for example, by IPA, where one basic shape correlates with exactly one sound and one sound is always written with the same basic shape.

Table 6: Criteria for the evaluation of writing systems and scripts

Venezky (1977)	Coulmas (2009)	Cahill (2014)
— mechanically suited for the language it is to reflect (1b) — compatible with [...] its social-cultural setting (3) — psychologically/ pedagogically appropriate for its speakers (2)	— convenience (2) — tools (2, 3) — general applicability and linguistic fit (1b) — expressive power (1ab) — simplicity (1ab, 2) — stability through time (1b) — monochrome coding (1, 2)	— linguistically sound (1b) — acceptable to all stakeholders (3) — usable (2, 3)
Baroni (2011)	**Smalley (1964)**	**Bauernschmidt (1980)**
— maximum distinctiveness (1ab, 2) — size of the graph(em)ic inventory (1ab, 2) — cognitive salience (2) — maximum naturalness (1ab, 2, 3) — inner consistency (1ab)	— motivation for the learner (2, 3) — representation of speech (1b) — ease of learning (2) — transfer (3) — ease of reproduction (1a)	— linguistic factors (1) — psycholinguistic factors (2) - „magic of written language“ - native speaker reaction - optimal inventory of symbols - overuse of symbols — sociolinguistic factors (3) - symbol value - adjustments for dialects - unity of language families - prestige, numbers, and so forth - established alphabets - government agencies - transfer value — practical factors (3)
Rogers (1995)	**Daniels & Share (2018)**	
— linguistic (1b) — psychological (2) — cultural (3) — technical (3)	— linguistic distance (1b) — spatial arrangement and non-linearity (1a) — visual uniformity and complexity (1a) — historical change (1b) — spelling constancy despite morphophonemic alternation (1b) — omission of phonological elements (1b) — allography (1ab) — dual purpose letters (1ab) — ligaturing (1ab) — inventory size (1ab, 2)	1a. systematic fit 1b. linguistic fit 2. processing fit 3. sociocultural fit

The parameters of transparency and uniformity are used to describe whether the graphematic/orthographic module[268] is *shallow* (e.g. Finnish) or *deep* (e.g. English) (cf. Katz & Frost

[268] Mentioning both modules in this context is not an indication of a reluctance to commit, but related to the question: what do the attributes *shallow* and *deep* truly refer to? I argue that it can be both modules: a writing system is shallow if the graphematic relations between basic shapes and linguistic units are

1992), which represents a gradual distinction referred to as *orthographic depth* and can be used to help assess (part of) the linguistic fit of a given writing system.

Share & Daniels (2016: 23-26; Daniels & Share 2018: 104-110) point out that this monodimensional concept of orthographic depth applies predominantly to European alphabets and challenge its value for other types of writing systems. Indeed, the concept of orthographic depth only concentrates on the *phonological* biuniqueness of writing systems and thus only applies to phonographic writing systems. However, biuniqueness as a semiotic criterion can be applied also to the relations between basic shapes and other, non-phonological linguistic units: this way, the transparency and uniformity of graphemes in the Chinese writing system, which refer to morphemes, can also be evaluated, whereas – since Chinese graphemes only offer (often opaque) clues to pronunciation – the Chinese writing system is automatically discarded as "deep" by the phonology-centric orthographic depth hypothesis. Acknowledging this "monodimensionality", Daniels & Share (2018: 104-110) propose ten dimensions of orthographic depth: (1) linguistic distance: differences between spoken and written language, (2) spatial arrangement and non-universality, (3) visual uniformity and complexity, (4) historical change: retention of historical spellings despite pronunciation change, (5) spelling constancy despite morphophonemic alternation, (6) omission of phonological elements, (7) allography, (8) dual purpose letters, (9) ligaturing, and (10) inventory size.

Not all of these dimensions can be neatly categorized as pertaining to the linguistic fit (cf. also Table 6) as some of them concern the processing fit of writing systems (see below) and some are not concerned with the fit of writing systems or their graphematic modules at all, but rather with scripts (such as "visual uniformity and complexity"). Altogether, the dimensions that Share & Daniels propose for a more universal and inclusive concept of orthographic depth roughly correspond with the considerations that I subsume under the label of the naturalness of scripts and writing systems. This is underlined by the fact that Share & Daniels (2016: 26) "regard these 10 dimensions as merely a catalyst for discussion of the multi-dimensional nature of writing system complexity". However, their dimensions are not systematically categorized and, not unlike many of the other criteria listed in Table 6, they are predominantly inductive, which is why the authors admit that "[i]n several cases, […] the dimension has yet to be addressed empirically" (Daniels & Share 2018: 104). I argue that analyzing scripts and writing systems in a naturalist framework, which requires external evidence, is a systematic way of assessing a script's or writing system's complexity, or, in naturalist terminology, (un)naturalness.

The systematic fit of scripts and the linguistic fit of writing systems are determined descriptively and without recourse to external evidence, which does not hold for the next two categories, the relevance of which has been underlined, for example, by Venezky (1977, 2004).

The 2) *processing fit* of scripts and writing systems describes the relationship between writing and the human faculties necessary to process it: how suited are a script or writing system for the hands, the eyes, and the brain? What is termed *processing fit* here is, in large part, synonymous with the traditional definition of naturalness in Naturalness Theory that defines those structures as natural that are easier to process by humans (cf. Section 1.1). The following questions are pertinent to the processing fit: What features of scripts and writing systems make them easier or harder to process? Do the systematic fit of scripts or the linguistic fit of writing systems affect their respective processing fits? More generally phrased: Does the structure of a system influence the performance of its users in using it, and if so, how? Hypothetically, the processing fit of writing could be determined first and, based on the results, assumptions could be made about the systematic and linguistic fits. The broadest hypothesis concerning the rela-

predominantly transparent, while an orthography is shallow if the prescriptive *standardization* of the writing system is transparent. In theory, a writing system whose graphematic module exhibits a high degree of transparency could still be deep because of idiosyncratic and unsystematic orthographic conventions (cf. Section 3.4).

tion of the two is: the better the systematic or linguistic fit of a system, the better its processing fit. The same is expected to hold vice versa. Intuitively, the processing fit appears to be a consequence of the systematic or linguistic fits. However, the inverse relation should also be considered: in the process of the diachronic development of scripts and writing systems, the actions of users might lead to a change or elimination of some features (in the vein of 'invisible hand'-theories, cf. Keller 2014 and Section 1.3.4) when these are not in agreement with processing needs. In this way, the processing fit, in the sense of "human pressure", can also influence the systematic and linguistic fits (cf. also Dehaene 2009).

Along with purely descriptive as well as physiological, psychological, and neurobiological constraints, sociocommunicative, ideological, and cultural aspects also contribute to naturalness or unnaturalness in writing. The 3) *sociocultural fit* deals with questions relating to this kind of naturalness. This aspect had been relegated to the background in Naturalness Theory. As Dressler (1980: 75) notes, "typical 'naturalists' implicitly agree with a methodological separation of the psychological/biological and the social factors. The former must be dealt with first, the latter later on. Unfortunately, most of us tend to omit or postpone indefinitely the treatment of social factors [...]". With the inclusion of the sociocultural fit, these aspects shall not be excluded in a proposal of Natural Grapholinguistics. Cahill (2014) describes several non-linguistic factors that play seminal roles in the context of the creation of new writing systems for as-yet unwritten languages, including the adoption of an existing script or the design of an entirely new script. These factors include governmental policies that are enforced upon writing systems, sociolinguistic factors such as attitudes towards dialects and other languages (e.g., wanting the writing system to 'look' or *not* to 'look' like the writing system of another language), and the associated wish to signal affiliation with or distance from a certain social group (cf. also Sebba 2009 and Unseth 2005). Whether a (new) writing system succeeds depends crucially on the consideration of these factors, which is why Cahill (2014: 23) stresses "the importance of local community involvement" for the creation of new writing systems. If a community dislikes and rejects a writing system that has been devised for its language, the system has effectively failed, even if its linguistic and processing fits exhibit high degrees of naturalness. The fact that these sociocultural factors often trump linguistic and processing factors more than warrants their inclusion in studies like the present one. It makes it a necessity.

Additional factors that could also be assigned to the sociocultural fit as they stem from the need to communicate through a given writing system are *technological factors*. These include the availability of typefaces and keyboards suited for a given script that make the use and dissemination of a writing system possible. Technological factors showcase a categorical difference between speech and writing: to write, we need tools (cf. Dürscheid 2016: 31). A question that is central for the technological fit of a script is whether it is already included in Unicode. Controversially, with its decisions, the Unicode Consortium has the power to decide what is included and, consequently, which scripts can be used electronically.

The subdivision in three fits is a modification of Naturalness Theory as it was characterized in Chapter 1. However, to some degree, these fits existed implicitly in the theory: in NM, the linguistic and processing fits were central, since the semiotic structures of the morphological level of language (= the linguistic fit, or more generally, semiotic fit) were assumed to directly affect processing (= the processing fit). Processing was also at the forefront in NP, were natural processes were proposed on the basis of physiological processing. Sociocultural considerations, as already mentioned above, were cited as relevant in the theory but did not occupy a central role in the actual research.

In conclusion, the criteria shown in Table 6 as well as the three fits they are assigned to serve as important orientation tools that can be used by researchers in organizing natural features of and in writing systems after they have been deduced from external evidence. The following evaluations of the naturalness of scripts (*Natural Graphetics*) and writing systems (*Natural Graphematics*) will be structured according to these three fits.

3.1.2 Transfer of concepts and ideas from Naturalness Theory

This subchapter deals with the question of how certain cornerstones of Naturalness Theory that were described in Chapter 1 can be transferred to Natural Grapholinguistics. Some of these observations have already been introduced throughout this thesis; now they will be collected systematically. Note that this treatment is still of cursory and introductory nature as it emphasizes on illustrating how Naturalness Theory links to Natural Grapholinguistics by giving examples. In the following subchapters, the grapholinguistic aspects will be given an in-depth treatment; however, there, the links to concepts of traditional Naturalness Theory will not be specifically underlined.

Concepts that appear crucial for the proposed Natural Grapholinguistics are the subtheories of naturalness (system-independent, typological, and system-specific naturalness), the physiologically determined natural processes, the semiotic naturalness parameters, naturalness conflicts, and methodological considerations, especially the inclusion of external evidence. Some of these concepts are grounded in NP (Section 1.2), others in NM (Section 1.3). Together, as a theoretical core, they are all constitutive for Natural Grapholinguistics. All of them can be analyzed both under a material, i.e. graphetic perspective, and a linguistic, i.e. graphematic perspective.

3.1.2.1 Subtheories of naturalness

In NM, three subtheories were postulated: *system-independent naturalness, typological naturalness*, and *system-dependent naturalness* (cf. Section 1.3.1). They can be transferred productively to Natural Graphetics and Natural Graphematics. Questions of the systematic/linguistic, processing, and sociocultural fits can be asked at all of the three sublevels, although the fits appear to correlate predominantly with one level (see below).

The level of *system-independent naturalness*, also referred to as universal naturalness, investigates the question of what is preferred universally. For the graphetic module, possible questions could be: What is the universally preferred visual configuration of basic shapes? What is the preferred motoric program for the production of basic shapes (cf. Watt 2015)? What are the universally preferred features of a script that render it a sound, coherent visual system? What are the features of scripts that make them easy and more efficient to read and write? And how, in general, can scripts be more or less suitable for given sociocultural environments? Evidently, some of these questions are more reasonably, though not exclusively asked at a universal level (questions of the systematic and processing fits) than others (problems pertaining to the sociocultural fit). The latter might be better located at a lower level, i.e. the typological or even the system-specific level at which the fit of a given script for a given culture can be determined by taking into account highly idiosyncratic factors that arise in an individual context.

Regarding system-independent graphematic naturalness, major questions are: What is the preferred semiotic structure of graphemes? What is the preferred assemblage of graphemes in a grapheme inventory? These questions could be subsumed under the more general question: What is the most natural relationship between the visual and the linguistic? When it comes to the processing of writing, a major question is how the semiotic structures influence cognition. While material preferences regarding basic shapes have already been assessed in Natural Graphetics, and the naturalness of the linguistic units that graphemes represent – phonemes, syllables, morphemes, etc. – is not treated by Natural Graphematics but by the other components of Naturalness Theory (NP, NM, and others), the question whether one *type* of linguistic unit that graphemes represent is universally preferred has indeed been a question of interest, as a “primacy of the syllable” (Daniels 2018: 12) has been postulated. It claims that syllables are more natural as processing units than segmental phonemes (cf. Section 3.3.2.1).

The second subtheory, *typological naturalness*, deals, graphematically, with the relationship between types of language (isolating, agglutinating etc.) and types of writing (phonographic, morphographic). It is in this context that Halliday's ([1977] 2010: 103, my emphasis) oft-cited quote "[i]n the course of this long evolution, a language usually got the *sort* of writing system it deserved" becomes interesting. When he mentions a *sort* of writing system, what he is most likely referring to is its *type*. Compared with the number of assumed language types, types of writing systems are surprisingly sparse. The basic dichotomy between phonographic and morphographic writing systems becomes only minimally nuanced by the establishment of several subtypes of phonographic systems (cf. Section 2.3.2), but then again, as Weingarten (2011) noted, writing system typology might still be in its infancy. Is Halliday correct in his opinion? Do languages get the type of writing system they "deserve"? Do features of language types associate with certain features of types of writing systems?

The questions at the typologically graphematic level predominantly concern the linguistic fit, but they do also venture into the processing and sociocultural fits. One prominent example is the question whether the morphographic Chinese writing system could be written with an alphabet (cf. Meletis 2018: 72; Rogers 1995: 39; DeFrancis 1943; cf. Section 3.3.1.1). Many argue that because of the isolating nature of Chinese and the sheer abundance of homophony, writing Chinese alphabetically would lead to ambiguities that would render the writing system less natural from a processing perspective. Absurd situations would arise in which an identical graphematic word could be reproduced several times in a minimal context, each time representing a different morpheme, i.e. a different meaning.[269] Also, precisely because Chinese is an isolating language, meaning there is no need to graphically encode inflectional information, a morphographic writing system in which the graphemes each represent a morpheme is clearly the most economical solution. Finally, the question of why the Chinese have not opted to replace their system with an alphabet is at its core also a deeply cultural question (cf. what DeFrancis 1943 calls "the social problem"). Adopting a different script and with it a different type of writing system would drastically cut ties with thousands of years of cultural tradition, a decision that could, to name an additional aspect, also be interpreted as bowing to the pressures of the West and "admitting" that the West and its inventions – such as the alphabet – were superior. This, of course, is not true, which might be an additional reason why the Chinese hold onto their traditional script and their morphographic writing system. Also, one of the main advantages of the morphographic Chinese writing system is that it enables the mutual intelligibility of different Chinese 'dialects' and politically unites them even when spoken pronunciations are not mutually intelligible (cf. Chen 2004: 114-128). If a strictly or even predominantly phonographic writing system was employed, this advantage would be eliminated.

Since there is no typology of scripts as of yet (but cf. Section 2.3.1), it is difficult to imagine how typological graphetic naturalness could be assessed. If a base criterion for a typology were to be identified, for example *roundness* vs. *angularity*, questions pertaining to the resulting types could be examined, such as: Is the round type of scripts (as evidenced by Georgian script, Telugu script) more easily read and written than the angular type of scripts (Chinese, Korean, etc.)? However, since no such types have been assumed and described yet and it is merely one goal of this thesis to uncover reasonable choices for typological base criteria, the investigations of questions such as these must be postponed to a later stage of this naturalist grapholinguistic enterprise.

The last subtheory extensively covered in NM is *system-dependent naturalness*. At this level, the central question is: what is natural in a given script or a given writing system? With respect to this question, too, all of the fits can be assessed, and some questions are, in fact, most reasonably asked at this level. Graphetically, questions pertaining to single scripts are: what are

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[269] Chao (1968: 120) gives the extreme example of a story consisting of 36 instantiations of the syllable *xi* with one of the four tones. He notes that "[i]t makes absolutely no sense when read aloud in modern Mandarin, but from the writing a reader of classical Chinese can make out the story [...]".

the features of a given script and how do their naturalness values interact? Are they in conflict with each other? Here, specific examples can be discussed such as |J| which is an outlier among the uppercase basic shapes of Roman script. Why is it an outlier and how does its status affect the systematicity of the entire script? How does it affect the processing of this exceptional unit and processing of the whole script? From a sociocultural perspective, what are, in a specific environment and situation, cultural, ecological, technological, social, and political factors (cf. Downey 2014) that influence the choice of a script for a given writing system?

Graphematically, each writing system offers a unique set of system-dependent naturalness values on the parameters that were identified as crucial at the system-independent level. At the system-dependent level, the observation that there exist no "pure" writing systems is interesting. Type-mixing is almost always involved, so questions of how individual systems choose to solve specific problems can be asked at this level: Why does German opt to give the morphographic principle some weight, writing <Kälte> 'the cold' instead of <Kelte> 'Celt' when referring to the noun derived from the adjective <kalt> 'cold'? And why is this morphographic principle not as important in an alphabet such as Finnish? It is at this level that the linguistic fit can be assessed for individual writing systems, evaluating how well a given writing system fits a given language. The processing fit of a given system might also deviate substantially from the universal or typological processing fit: take Thai, which is an abugida (or, per Gnanadesikan 2017, a mostly vowelled āksharik/linear segmentary, cf. Section 2.3.2) but deviates from many other more 'typical' abugidas. In Thai, not all vowel graphemes are smaller in size than consonant graphemes, as some of them are of equal size. Additionally, in Thai, some vowel graphemes spatially precede consonant graphemes although, in the phonological structure that the graphemes represent, the vowels temporally follow the consonants. Winskel (2009) terms this phenomenon *misaligned vowels*. These idiosyncratic features take a toll both on the linguistic and processing fits of the Thai writing system which has a dramatic effect on its system-dependent naturalness. Finally, with respect to system-dependent graphematic naturalness, the sociocultural fit takes center stage: what, for example, are the sociocultural factors that ultimately decide how a writing system is designed for a yet unwritten language?

These three subtheories or levels of naturalness interact with each other. Crucially, a lower level has the potential to override higher levels: typological naturalness can override system-independent naturalness and system-dependent naturalness can override both system-independent naturalness and typological naturalness. While universal preferences are relevant mostly in the search for general explanations of why certain structures recur across writing systems, lower levels are needed to explain more specific structures and exceptions. In other words, the system-independent level, and to some degree, the typological level, are concerned with the unity, the shared core of all scripts and writing systems, whereas the system-dependent level captures the diversity of individual scripts and writing systems. Two additional levels of linguistic analysis were not given an elaborate treatment in NM: norms and performance. The increase of power of lower levels continues through these levels: the level of norms can override all higher levels, as can the lowest level of performance. One reason why they might have remained undeveloped in the context of NM is that it is not straightforwardly clear how naturalness should be assessed at these levels.

Although it was set aside in traditional Naturalness Theory, the existence of the orthographic module of writing systems highlights the importance of the level of norms for a Natural Grapholinguistics. Norms superimpose both the graphetic and the graphematic module. In graphetics, conventions remain mostly implicit. For example, many people share the idea that it is not appropriate to use a 'childish' font such as Comic Sans when designing a resume (cf. Meletis in press b). Rules might be explicit, too: in Chinese, forgetting or misplacing a stroke, producing a wrong stroke, omitting a stroke in a character, or producing the strokes in the wrong sequence (cf. Law et al. 1998) are all graphetic mistakes. These mistakes might result in the production of another basic shape which is part of a different graphematic relation, in which case a graphetic mistake becomes a graphematic mistake. In Arabic, too, when a dot is omitted or misplaced, the result can be a different basic shape than the one intended, such as |ﺪ|

instead of |ذ|, two distinct basic shapes that take part in different graphematic relations (cf. Brosh 2015). Although it lacks visual salience, the dot can serve as a distinctive visual feature in Arabic script – in examples like these even the only one. Consequently, if it is omitted, a different grapheme will be invoked, and the word is misspelled. Minimal graphetic distance between two distinct shapes is, thus, a source of mistakes.

Mostly, however, the level of norms interacts with the linguistic fit of a writing system: explicit and codified orthographic norms as found in dictionaries superimpose the graphematic level and restrict the graphematic solution space by selecting one or more variants as correct. In some cases, the spelling that is selected and codified as normatively correct is not even located within the graphematic solution space, which means it is a spelling that is not licensed by the graphematic module (cf. Section 2.2.3). How can unnaturalness of this kind be introduced? The answer to this lies in the fact that the level of norms – at least with respect to the standardization of the graphematic level – is generally determined externally in that it is not imposed upon a system by most of its users in the vein of 'invisible hand' theory but instead by minorities with authority, in most cases commissioned institutions. However, even orthographic rules that have been codified by commissions are, to a large degree, based on the conventions upon which language users have initially and implicitly agreed (cf. Keller 2014; Neef 2015: 716; Dürscheid 2000). In the case of German orthography, for example, the actual use of the system is observed and taken into account by the *Council for German Orthography*, the institution that decides on the rules (cf. Güthert 2016: 16-20).

Of course, the arbitrary character of some orthographic rules stems partially from the fact that they are not designed primarily with the goal of exhibiting the most natural processing fit. In an investigation of the naturalness of writing, orthographies act as kinds of "walls" in front of the linguist because they greatly complicate the search for natural elements in the graphetic and graphematic modules behind them. This is due to the fact that the arbitrary orthographic surface that users produce often does not reveal what is going on in their minds. Therefore, violations of orthographic norms, whether they are conscious or unconscious, are central to the investigation of grapholinguistic naturalness. Licensed variation, i.e., the use of different variants *within* the realm of orthographic norms, is also highly relevant since it reflects the flexibility of the underlying writing system and can be used to investigate writers' implicit and explicit preferences.

Deviations and variation already lead us to the last and lowest level: performance. The actual performance by readers and writers of a system may diverge from the system and its system-dependent naturalness. Whether – as already stated above – they are conscious or unconscious, all types of deviations – errors, mistakes, and variation – may reveal how something at the performance level is more natural than at the levels above it. An interesting question is whether the system-independent naturalness that was potentially overridden by typological naturalness or system-dependent naturalness actually resurfaces at this level of performance, in other words: whether system-independent naturalness and performance naturalness are in fact the same thing. This would be precisely the reason why mistakes and errors are treated as external evidence (cf. Section 1.3.3) pointing to the system-independent naturalness of writing.

3.1.2.2 Natural processes

In the transfer of NP's ideas to Natural Grapholinguistics, the most imminent question is how the concept of natural processes (cf. Section 1.2.2) can be reinterpreted within the domain of writing. In this section, I want to investigate the question of whether there exist natural processes in writing, and if so, what they could be and how they compare to natural phonological processes. Before I proceed, I want to note that – as the term natural phonological *process* already aptly illustrates – NP concentrated on the dynamic processes of the production of speech products and only secondarily on the products themselves. These processes are always intricately linked to humans carrying them out, so they are always a matter of the above-described processing fit of scripts and writing systems. They cannot be described independently of human production and perception.

NP focuses on the processes that occur due to limitations of the articulatory apparatus. Is there an analog in writing? Are there natural graphetic processes that arise from the difficulties of the physical act of writing? Evidence suggests there exist some sequences of basic shapes in the handwriting of children that seem to be harder to produce than others (cf. Gosse et al. 2018; cf. Section 3.2.2.2). Movements made in handwriting (as studied by *graphonomics*, cf. Kao et al. 1986) can generally be viewed through the lens of naturalness. The central question here is which basic shapes or combinations of basic shapes[270] require less effort in production than others and are, thus, potentially preferred by writers. These preferences might or might not act upon the inventory of basic shapes in a script and the *graphetic* (and in turn, *graphematic*) *graphotactics* of a given writing system. Given basic shapes or combinations of basic shapes that are dispreferred might be avoided in usage, which could, consequently, lead to changes in the system. Difficulties in the writing process of certain graphetic sequences are more or less an exact analog of the difficulties that arise from sequences of phonemes in speech, where one feature of one phoneme in the sequence is changed to render an utterance more easily pronounceable. For writing, however, tools are necessary, so a variety of tools and different modes of writing need to be taken into account: typing on a keyboard, for example, also counts as writing even if it is, physiologically speaking, a completely different process than writing with a pen. What is natural in typing? A quaint question that appears trivial but must definitely be considered in an evaluation of the naturalness of typing is the placement of the individual keys: is the QWERTY layout of conventional English keyboards natural (cf. Noyes 1983; cf. also Section 3.2.2.2)?

Let us reconsider the list of characteristics of natural phonological processes given in Section 1.2.2 and discuss whether they also apply to natural graphetic processes. I argue that natural graphetic processes such as in the production of connections between basic shapes in cursive script are, just like natural phonological processes, *unconscious*. In general, natural graphetic processes are physiologically conditioned (which subsumes human biology, writing instruments, and the writing surface). With respect to human endowment necessary for writing processes, they are *innate*. The difference in ontology – speech is “inborn”, writing must be learned through instruction – does not affect the fact that the pre-existing biological conditions are innate in both cases. The difference is that writing – unlike speaking – is not solely dependent on the innate physiological conditions of the human hands and eyes, but also on the tools that are used. If certain natural graphetic processes are caused only by limitations of the hand, then they are indeed *innate*. If, however, processes are caused by external factors such as the pen or the keyboard that is used and could be avoided by the use of different tools, they are not innate. If typing on a keyboard with a specific layout is more natural than on a keyboard with a different layout, then this is due to the nature of the tool. The tool, of course, always interacts with the innate physiological limitations of the human hands, but the crucial point is that ensuing natural graphetic processes are not caused *solely* by innate human biology. Commonly, whenever a given graphetic context is met, natural graphetic processes are applied, which means they are *automatic*. However, just like natural phonological processes, natural graphetic processes are universal, but they are not applied universally: they are *variable* and,

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[270] A question that was already raised in the context of NP is relevant for Natural Graphetics, too: is it possible to evaluate isolated units without a context? I believe it is, which will be shown in the discussion of the processing fit of scripts (cf. Section 3.2.2). Unlike phonemes, basic shapes are not restricted in their materiality, which means the number of possible basic shapes is probably infinite while the number of phonemes that can be produced by humans is most certainly finite. The different features of basic shapes – e.g. their degree of complexity – strain human capacities to different degrees. Furthermore, at a lower level, most basic shapes consist of more than one segment and are thus inherently complex, which means that multiple movements are necessary to produce them. In other words, natural graphetic processes can occur within individual basic shapes and basic shapes can be compared with respect to which and how many natural graphetic processes they evoke.

thus, in a way, *optional*. What applies to speech also applies to writing: if writers are tired (cf. Parush et al. 1998), drunk, or write particularly fast (cf. van Drempt, McCluskey & Lannin 2011), just to name a few factors, this potentially affects their writing and the natural graphetic processes they apply or fail to apply. The fact that the application of processes is not obligatory means that the application or non-application has the potential to be sociosemiotically charged. Thus, even if they are primarily conditioned physiologically, natural graphetic processes can also be conditioned sociopragmatically, e.g. when a writer – out of respect for the addressee, for example (see below) – attempts to write in an especially legible (or even aesthetically pleasing) manner.

While natural graphetic processes are automatic and conditioned physiologically, in writing, there also exist analogs to the morphophonological rules of NP: in alphabets that are equipped with two distinct inventories – lowercase basic shapes and uppercase basic shapes –, the first grapheme in a graphematic sentence is realized by an uppercase basic shape. This is a graphematic rule. It is not conditioned physiologically, and one could very well imagine the basic shapes at the beginning of sentences also in lowercase (as in the Georgian alphabet which lacks a case distinction). As discussed in Section 2.2.2.2, the sentence-initial majuscule is conditioned by other linguistic factors. Thus, it is not a natural graphetic process or even a natural graphematic process, for that matter. It is a rule.

Perception was not the primary focus in NP, as all described natural phonological processes were of articulatory nature. However, as Dressler (1984: 33) argued, for speech, perception is primary and articulation only secondary. Some claim this also holds for writing (cf. Primus 2006: 10), since members of literate societies are more often readers than writers and writing always simultaneously includes a feedback process of reading what has been written or is being written. This primacy ultimately raises the question of whether there exist perceptual natural graphetic processes. A possible example is the identification of an illegible graph in a given written word due to the available context. Could this process – assigning an illegible graph to a basic shape because of the graphematic context – be a perceptual natural graphetic[271] process? One aspect that sharply distinguishes productional natural processes as described in NP from these proposed perceptual processes is that the productional processes change the output, the product. Perceptual processes, on the other hand, do not change the product that is being materialized but always work with an *existing* or *emerging* product. However, I argue that a process is not defined by how it affects linguistic outputs, but precisely by how it affects articulation and perception. In this view, perceptual natural processes *do* change the product, too, but a different kind of product: while they do not alter the actual materialized product – whether acoustic or visual – they change the mental product in the mind of the hearer or reader. This corresponds with Donegan & Stampe's (2009: 26) claim that hearers do not hear what speakers actually say, but what speakers intend to say. Thus, if a speaker were to "fail" to apply an articulatory natural process, as they are variable (and the speaker might be tired or drunk, for example), said process might still be perceptively applied by the hearer.[272] I argue that the same holds for writing: if someone produces an utterance rather illegibly and the reader has to

[271] Strictly speaking, it must be a natural graphematic process, since it is not the graphetic context – i.e. only the visual appearance of the surrounding graphs – but the *graphematic* context and the linguistic information that it gives that allow identifying the graphematic status of the unidentified graph, i.e. the graph is identified top-down. If a certain graph in a given word is completely illegible, it might never be recognized as a member of a given basic shape, but even then, because of the graphematic context, the abstract *grapheme* it is a part of is identified.

[272] An interesting question that, however, is beyond the scope of this study, is whether perceptual processes in writing could also be categorized as productional processes in line with the motor theory of speech perception. If processes are applied at the perceptual stage and change the mental product, these processes could hypothetically be categorized as being similar to productional natural processes. There are indeed studies that show motor areas in the brain are activated when handwriting is being read, suggesting "embodiment of the visual perception of handwritten letters" (Longcamp, Hlushchuk & Hari 2011: 1250).

make more of an effort in deciphering it, the writer's lenitions require fortitions on the reader's behalf.

Given the richness of visual variety in writing, the horizon must be widened in the conception of natural processes: for example, printing something bold, underlining it, or setting it in a larger font size in the electronic writing process could be interpreted as (conscious) graphetic and simultaneously graphematic (see below) fortitions. Graphetic fortitions can generally be defined as processes – whether conscious or unconscious – that make the product more *legible* for the addressee. Note the crucial difference between *legibility* and *readability*: text needs to be legible on a material (i.e., graphetic) level to be visually *recognized*, whereas text needs to be readable on a conceptual (i.e., graphematic) level to be *understood* (König 2004: 18; Lund 1999: 15-20). Legibility is a part of readability. If a writer attempts to make his writing more readable (see below), the resulting process is not a graphetic, but a graphematic fortition.

Graphemes are signs whereas phonemes are not. As conceptualized in NP, phonemes are simultaneously material and linguistic units. By contrast, in this thesis, graphemes are defined as relations between material and linguistic units. Natural phonological processes apply to phonemes, that is units that are simultaneously material and linguistic, while graphetic processes apply only on the material units, i.e. the graphs and the basic shapes they are assigned to, but not linguistic units. Accordingly, for speech, natural processes are crucial as they determine the phoneme inventory of a language. In writing, on the other hand, they can only determine the perceptual and, thus, categorical boundaries between basic shapes. How these basic shapes which are perceived as different units enter into graphematic relationships with linguistic units to form graphemes is *not* determined by natural processes. Thus, if a sequence of two basic shapes is hard to produce in handwriting, the individual shapes might be changed to alleviate the production process. However, it can be claimed that in natural graphetic processes, basic shapes are commonly not substituted by basic shapes that take part in different graphematic relationships. In speech, on the other hand, changed segments might have a different phonological status than the original segments, such as when /s+d/ changes to either [st] in Basque or [zd] in Spanish (cf. Section 1.2.3.2). With respect to this example, the question is: how can this result of natural phonological processes – altering one feature of a phoneme – be transferred to natural graphetic processes? I argue that a transfer of this kind would require a consistent theoretical and methodological approach of segmenting graphs or basic shapes of all scripts of the world into their respective features, an enterprise that, not only, but predominantly because of the vast visual richness exhibited by the myriad scripts of the world, has not been successful yet (but cf. Section 3.2.1).

A fitting example for shapes that developed handwriting variants which are so distinct that they were conventionalized as different allographs of one grapheme is intra-inventory positional allography in Arabic (cf. Section 2.2.2.2). Synchronically, using different basic shapes depending on the position in which graphemes are realized is comparable to the use of sentence-initial majuscules, which was characterized as a graphematic rule. However, similar to morphophonological rules which might have started out as natural phonological processes and still show remnants of a phonetic motivation, this graphematic rule, too, started out as a natural graphetic process: the different allographs of one grapheme, as is visible to this day, are adjusted to the position in which they appear within a word and to the graphetic connections that need to be made on one or both sides of them. Thus, their visual appearance is motivated by articulatory pressure to connect the shapes with their surrounding shapes – a natural graphetic process (cf. also Section 3.2.2). However, what started out as automated variants has developed into a conventional rule, as one basic shape with four variants was split up into four different basic shapes. It is of secondary interest whether these shapes belonging to one grapheme are visually similar. What is more relevant is that all the positional variants for one position (initial, medial, final) are adjusted to the position they are realized in (except for the non-connecting shapes) and to the graphetic connections that need to be made. The synchronic visual appearance of Arabic script is thus still visibly determined by this natural graphetic process, even if it has turned into a rule.

As mentioned above, natural graphetic processes are variable. Consequently, just like in NP, two types of lenitions and fortitions must be differentiated: first, there are those lenitions and fortitions that are caused purely by physiology, e.g. because a sequence of basic shapes is hard to produce physiologically. These processes are non-semiotic. However, the application of processes – because it is neither obligatory nor universal – can be sociosemiotically charged. Here, the example of pre-modern Japanese letter writing is fitting, where a writer's lenitions conveyed the addressee's lower social status and fortitions were indicative of the addressee's equal or higher social status (cf. Section 1.2.3.2). Lenitions and fortitions, thus, do not have to be, but definitely *can* be indexical of the communicative situation. It seems trivial to point out that the appearance of writing on a shopping list one has written for themselves might differ from the appearance of writing on a birthday card intended for someone else, but this is exactly where lenitions and fortitions are semiotic in nature.

When writers seek to improve the *readability* of a written utterance, this involves not (only) natural graphetic processes, but natural *graphematic* processes. A crucial difference between the two is that graphematic processes are motivated predominantly by conscious choices. For these graphematic processes, there exists no real analog described in NP. If a speaker attempts to consciously enhance the acoustic quality of his speech, this conscious choice would result in (probably unconscious) fortitions and this would enhance intelligibility.[273] What, however, could be a phonological analog to a writer's conscious decision to avoid rare abbreviations in writing and to fully spell out words or to start a new paragraph to enhance the structure of a text in order to make it more readable? In speech, a possible analog could be something like natural rhetorical processes that are used to make speech more comprehensible, e.g. conscious choices not to produce spoken sentences that are too long or the decision of where to position pauses. These choices concern not the material quality of speech (volume, speech rate, etc.), but the structure of speech. The pair *legible* vs. *readable* in writing could thus be an analog of *intelligible* vs. *comprehensible* in speech.

One example for a natural graphematic process has already been mentioned: using or avoiding abbreviations. For a writer, using abbreviations usually represents a lenition. For the reader, on the other hand, it requires extra effort to decode a written utterance. Note that graphematic processes, since they always also involve the materialization of a written utterance, are intricately linked to the graphetic level. If a writer chooses to write "e.g." instead of spelling out "for example", this might not only be conceptually more economical for him (if it is that at all[274]), but it is also graphetically more economical since there is less motoric effort involved. Vice versa, printing a word bold when producing text on an electronic device requires extra effort for the writer graphematically, as he has to make the conscious choice of altering the structure and visual appearance of the text, and graphetically, as he has to press a button or combination of keys to actually render a portion of the text bold. Inversely, processes like this often improve both legibility and readability on behalf of the reader. Less or more graphematic effort, thus, often equals less or more graphetic effort.

To sum up, there are three types of natural processes in writing: first, there are (1a) unconscious graphetic processes such as the ones that are conditioned physiologically and change the shapes of handwritten graphs. In the case just described, they are determined solely by physiological limitations. And since writers are rarely aware of these limitations, these natural graphetic processes are unconsciously motivated. There is a second type of (1b) unconscious graphetic processes, and these are consciously motivated: they include processes invoked by someone's decision to produce a written text in an aesthetically pleasing way. Here, the deci-

[273] Note that the decision to speak more clearly is conscious. However, the processes that this decision evokes might not be (or do not have to be) conscious. Crucially, the motivation for these processes is different: they are sociopragmatically motivated.

[274] Using abbreviations might not be more natural for a writer just because abbreviations are shorter. The fact that they are more economical in production does not mean that they are automatically less expensive cognitively. This would need to be tested empirically.

sion is conscious, but the processes it causes are not. These kinds of processes are still, at their core, physiologically conditioned, but whether they are applied or not is determined by other, often sociopragmatic reasons. Accordingly, graphetic features of texts can actually often aid the reconstruction of facets of the writing situation such as the relationship between the writer and the addressee. Next, there are actual (2) conscious graphetic processes such as setting something in italics in an electronic text document. In this case, it is not only the decision to render something more legible that is conscious, but also the process itself. Finally, there are (3) natural graphematic processes. These are always conscious. They necessarily go hand in hand with conscious graphetic processes: as already mentioned above, using an abbreviation such as "e.g.", since it must also be materialized, is always also a graphetic process.

Evidently, the natural processes of writing differ in crucial ways from natural phonological processes. The most fundamental difference is the fact that natural graphetic and graphematic processes can be conscious, whereas natural phonological processes rarely become conscious. They predominantly do so only negatively, as in L2 acquisition (cf. Section 1.2.3.2). Also, an inclusion of the level of natural graphematic processes – a phonological analog of which could be the mentioned natural rhetoric processes – is not only an extension, but in some respects a departure from classical Naturalness Theory. These processes are conscious and they are sociopragmatically motivated with the goal of enhancing communication. As outlined in Chapter 1, although underrepresented and underdeveloped, this sociocommunicative aspect is a crucial part of Naturalness Theory. For example, if a writer decides to structure his text into paragraphs to increase readability by making visually salient the thought units that these paragraphs represent, this is a departure from the classical conception of natural processes. As I argued, however, perception is also of importance, and in this particular example, the effort that is required of the writer to execute this *fortition* and produce separate semantically motivated paragraphs is counterbalanced by natural processes on behalf of the reader, which *are* physiologically and cognitively grounded and thus very much in line with the definition of natural phonological processes as defined in NP.

3.1.2.3 Naturalness parameters

The semiotic naturalness parameters of NM (cf. Section 1.3.2) can also be operationalized for the study of the naturalness of writing. This is made possible by the fact that graphemes and graphematic units in general are conceptualized as signs (cf. Section 2.2.2.1) that relate a visual signans with a linguistic signatum. In this vein, it is important to note that there are graphemes of different status: (i) phonographic graphemes are primary signs. These graphemes relate a visual basic shape such as |s| with a phoneme such as /s/ or a shape such as |り| with a syllable such as /ri/. By contrast, since the phoneme is itself not a sign, this grapheme is a sign of primary order. However, (ii) graphemes of secondary order are signs of signs: the basic shape |木| is in a relation with the morpheme {TREE}. This morpheme is itself a sign relating the phonological representation /mù/ with the meaning 'tree'. In many cases, the different status of these two types of graphemes can be disregarded and is not expected to make a difference in a general graphematic analysis. The relationship between the visual basic shape and the linguistic units, whether phonemes, syllables, or morphemes, is always of greatest importance, and this is true both for phonographic and morphographic systems. However, in the latter, there is an additional level of complexity as morphographic graphemes refer not only to the morphological level but simultaneously to the phonological level which constitutes the morphological level.

Bearing this in mind, the semiotic naturalness parameters can be applied both to graphemes as signs and grapheme inventories (and in extension, writing systems) as sign systems. Although in NM, it was postulated that the features of semiotic structures bear on cognitive processing, it often remained implicit how given semiotic structures precisely affect specific cognitive processes. It is in this vein that NM might want to borrow some traits from usage-based approaches to linguistics which treat cognitive processes much more explicitly (cf. Section 1.5.4). Thus, the ideas of NM, with its main interest in static semiotic structures and the naturalness parameters based on these structures, are most relevant in assessing the linguistic fit of writing systems but need to be extended to evaluate the processing and sociocultural fits.

Like natural processes, which were subdivided into natural graphetic and natural graphematic processes, some naturalness parameters can be applied both to graphetics and graphematics. This is due to the fact that some parameters (such as optimal shape and binarity, see below) are not concerned with the semiotic relation between the two constitutive parts of a sign, but with other features of the sign as a whole, including material features. That a large proportion of Chinese graphemes is characterized by a binary structure as they combine a semantic component with a phonological component (or a semantic component with a second semantic component), or that lowercase basic shapes of Roman script such as |b| can be analyzed as hierarchically complex visual structures with a primary head (the vertical stroke) and a coda (the smaller curve) are graphematic as well as graphetic or even solely graphetic applications of the parameter of binarity, for example.

Most of the naturalness parameters that were described in Section 1.3.2 can be transferred to Natural Grapholinguistics (examples can also be found in Meletis 2018: 76-80). What follows is a short characterization, as the parameters will be treated in-depth in the context of the linguistic fit (Section 3.3.1) and the processing fit (Section 3.3.2).

The NM parameter of 1) *constructional iconicity*, more widely referred to as *diagrammatic iconicity* or simply *diagrammaticity*, can be directly transferred to assess whether there is a diagrammatic relationship between the visual signans and the linguistic signatum. An obvious example for this is, again, Chinese <木> *mù* ‘tree’ and <森林> *sēnlín* ‘woods’. The conceptual semantic increase in the signata of the two morphemes (a single tree vs. the woods, i.e. many trees), which are the signata of the graphemes, is reflected diagrammatically by the increase of material substance in the basic shapes, the graphemes’ signantia. Furthermore, this increase in substance is doubly diagrammatic as it is not any shape but the shape used to represent the morpheme ‘(single) tree’ that is reduplicated to represent ‘many trees’, with the exception that the reduplicated shapes are adjusted in order to fit the fixed size of the segmental space in Chinese script. This parameter is much more central in Natural Graphematics than it was in NM, as aside from diagrammaticity, other types of iconicity can be assessed. One of them is imagic iconicity, which, in the case of writing, is known as *pictography*. Reconsider <木> *mù* ‘tree’, which is, even after thousands of years of use and development, still partially pictographic in its resemblance to a tree, or the basic shapes of Korean Hangul which (roughly) pictographically resemble the places of articulation of the phonemes they are in graphematic relations with (cf. Section 2.3.2). In the discussion of the linguistic and processing fits, the different types of iconicity and diagrammaticity in writing will be evaluated in detail.

The parameter of 2) *morphosemantic transparency* is, at first glance, also most relevant in morphographic systems. In Chinese graphemes of the *huíyì type*, i.e. semantic compounds (cf. Gong 2006: 45-47), two semantic components are usually combined to represent a morpheme that combines their two meanings compositionally, e.g. ‘hand’ and ‘tree’ which are combined to form the morpheme ‘to pluck, to pick’. Graphemes that are transparent in this way are maximally natural on the parameter of morphosemantic transparency. Since the parameter is interested in the nature of the composition of elements and can also be applied to phonographic graphemes, in the context of Natural Grapholinguistics, it shall be renamed *compositional transparency.*

3) *Morphotactic transparency* is concerned with the linearity of writing and the question of how basic shapes or even the graphemes they embody align with the linguistic units they represent. While individual graphemes might be transparent, in the context of a larger unit such as the graphematic word, they might not be sequenced in the order in which the linguistic units they represent are ordered. Prototypically, graphemes appear in the same sequence as the linguistic units they represent. In Thai, however, there exist so-called *misaligned* or *non-aligned vowels* as in <แบน>, which represents the word /bɛːn/ ‘flat’, but the actual graphemes appear in

the sequence *<ɛ:bn>. The vowel grapheme <แ> precedes the consonant grapheme <บ> (/b/) although, in the phonological representation, the vowel phoneme follows the consonant phoneme (cf. Winskel 2009: 22). In this example, the signans is not aligned with the signatum that it represents. This can be interpreted as an unnatural “opacifying obstruction” (Dressler & Kilani-Schoch 2016: 364). As this parameter, in the context of writing, is not necessarily related to morphology, I rename it *positional transparency*.

The parameters of 4a) *uniformity* and 4b) *transparency* can be used to assess the shallowness or opacity of the graphematic or orthographic module. Are linguistic units uniformly represented by basic shapes? This is central in spelling, i.e. production processes. Inversely, do basic shapes transparently represent linguistic units? This is relevant for reading, i.e. perception processes. If both of these parameters are simultaneously at their most natural values, then a written unit (whether a grapheme or a larger graphematic unit) adheres to the overall parameter of 4) *biuniqueness*.

The parameter of 5) *optimal shape* is the first in this list of parameters here that does not necessarily concern the descriptively assessed semiotic relation between signatum and signans, but the complexity of either the whole sign or only the signans of the sign. It is thus, in this thesis, treated exclusively a parameter of the processing fit. As mentioned above, this is one of the parameters that can be evaluated both graphematically, in which case it concerns the shape of the whole sign, and graphetically, in which case it is only concerned with the shape of the signans. Graphematically, the most central question is: what is the size of graphematic units, most reasonably interpreted as *length* in terms of the quantity of units, that is most natural for cognitive processing? An interesting claim that was postulated in NM (cf. Dressler 1987: 168) is that words are primary signs, i.e. signs of primary importance for processing. A simple transfer of this postulate to writing is problematic as there exists no coherent definition of a graphematic word across writing systems (cf. Section 2.2.2.4). However, if the unit of relevance here is not an independently defined graphematic word, but the written form of morphosyntactic words, then the question of how these words are represented in the writing systems of the world and whether these “written morphosyntactic words” are, for some reason, more central in processing than other graphematic units (such as the segmental grapheme) is an intriguing question. It has often been asked in the rendition: do we process individual units (e.g. letters) when reading or do we process whole words? Graphetically, when only the signans is of concern, the parameter of optimal shape invokes the concept of visual, or more generally, graphetic complexity. How much complexity is natural for the processing – the articulation and perception – of a basic shape or a larger sequence of basic shapes?

Some possible examples for a grapholinguistic interpretation of the parameter of 6) *binarity* which holds that binary structures are preferred to ternary or *n*-ary ones were already given above. They include the binary structure of many Chinese graphemes or the binary structure of Roman basic shapes. This parameter will not be treated separately as its exact nature for writing is not clear. However, its relevance might be re-evaluated in future reworkings of Natural Grapholinguistics.

In NM, the parameter of 7) *indexicality* deals with the temporal (or, in writing, spatial) relation i.e. proximity or distance between the different parts (= morphemes) of a sign (= word) and with the indexical relations between them. A possible graphematic question with respect to this parameter is, for example, how the different subsegmental components of Chinese graphemes are positioned within the segmental space. A more global question concerns higher levels of textual organization. In Natural Textlinguistics (cf. Section 1.4.2), the parameter of indexicality is interpreted intratextually and evaluates the relation between indexes and indexed signs in texts. This is crucial for complex texts such as this one that consist of different classes of elements – main text, headlines, footnotes, figures, etc. There are complex indexical relations between these elements, and questions of layout and spatial arrangement affect the naturalness of such texts for processing.

Similar to optimal shape, 8) *figure—ground* is a fundamentally perceptual parameter. The most salient figure—ground distinction in writing is the one between text vs. non-text, i.e. between segmental spaces that are occupied by written units vs. empty spaces. Empty spaces make visible different types of written units, which is expected to have a major influence on processing. Several other applications of the parameter are imaginable, one of which is how uppercase basic shapes in scripts with a case distinction are visually and possibly cognitively more salient than lowercase basic shapes. In abjads and abugidas, are the vowel graphemes, which are functionally and visually secondary and are often referred to as 'diacritics', the *grounds* to the more salient consonant graphemes, the *figures*? In general, with regard to the typology of writing systems, why does there seem to be a primacy of consonants, i.e. why are consonants much more often made out to be the salient figures to less salient grounds?

This leads over to a question that is unique to Natural Grapholinguistics since it deals with writing as a secondary semiotic system: the question which type of unit of the primary system, i.e. language, is a most natural candidate to be represented by the units of writing. Phonemes, syllables, morphemes? This question must be evaluated separately for the linguistic fit and the processing fit, and as such, the parameters I term *unit of representation* and *unit of processing* prove most clearly that a distinction between these two fits is not only reasonable, but theoretically necessary. With respect to the linguistic fit, when assessing the naturalness of different linguistic units, the structure of a given language must be considered, and crucially, its type. As already implied above, an alphabet would not suit the Chinese language well due to system-specific features that also affect the most natural choice for a unit of representation, which indeed appears to be the morpheme. Note that this parameter interacts fundamentally with variables such as the size of the grapheme inventory. A morphographic writing system will always have more units than a syllabic or segmental system, for example. The processing fit must be evaluated in the next step. Based on a variety of historical and experimental evidence, it has been postulated that the syllable is the most natural unit of processing (cf. Daniels 2018). Whether this claim is reasonable will be discussed in detail in Section 3.3.2.1.

As mentioned in Section 1.3.1, a given linguistic structure (or, see below, visual shape) cannot exhibit natural values on all of the naturalness parameters simultaneously, as these are in conflict with each other, a phenomenon referred to as *naturalness conflict*. This concept can be transferred straightforwardly to Natural Grapholinguistics. Naturalness conflicts will be particularly useful in showcasing how different scripts or writing systems or, on a typological level, types of scripts or writing systems deal with the same kinds of challenges in different ways.

A few more parameters were postulated in NM, some of them which are treated systematically in Crocco Galèas (1998). A question that I previously raised and affirmed was whether it is to be expected that more parameters will be found in Natural Grapholinguistics (cf. Meletis 2018). The accuracy of this claim depends on the definition of *parameter*. If parameters are to be understood only as facets of the relationship between signans and signatum, then even some of the parameters listed above technically do not count (such as optimal shape or unit of operation), as they are not concerned with this relationship but with different features of the sign or inventory of signs. For this reason, I opt for a broader reading of *parameter* that allows for the inclusion of other parameters, such as *unit of representation* and *unit of processing* (cf. Sections 3.3.1.1 and 3.3.2.1). As NM was only interested in the semiotics of morphological structure, and despite the double articulation of language, the parameters of NM are only peripherally concerned with materiality. Contrary to this, I argue that there are material naturalness parameters as well. To explain this claim, I want to further clarify my above-mentioned assumption that natural processes as described in NP, as well as naturalness parameters described in NM, are both material and linguistic, which means that there are naturalness parameters at the material level and natural processes at the linguistic level.

As stated above, NM puts its focus on synchronic linguistic structures whose semiotic features are assessed with the help of naturalness parameters. One type of external evidence that is used to evaluate which types of semiotic features are more or less natural is language acquisition. What if some of the mistakes that children make in production were to be seen as the products of so-called natural morphological processes? Overgeneralization, which is when a child produces a structure in a way that is regular in a given paradigm in which the correct form is actually irregular, such as German **geschmeißt* for *geschmissen* 'thrown' which is derived incorrectly from *schmeißen* 'to throw',[275] might be conceivable as a natural morphological process. Analogy of morphological structures, actually, is listed by natural morphologists as external evidence. I argue that analogy is a natural morphological process both in language acquisition in children and in the diachronic development of languages (i.e., language change). Thus, dynamic processes have resulted in the static semiotic structures that are studied by NM. For an analogous example in writing, take a spelling mistake in German in which a writer produces *<foll> instead of <voll> 'full'. Here, the wrong grapheme is chosen because the basic shape |f| is in a much more regular and straightforward relationship with the phoneme /f/ than |v|. The fact that <f> is a more natural grapheme with respect to the naturalness parameter of transparency leads to errors of this type. That the ensuing form – like the example taken from language acquisition above – is (orthographically) incorrect is not of relevance since the normative orthographic level has to be disregarded in an investigation of the actual system behind it. *<foll>, although orthographically incorrect, is certainly part of the graphematic solution space. The mistake of producing <f> instead of <v> could thus be modeled as a natural graphematic process that results from the fact that /f/ is not uniformly presented in the writing system, and as was already postulated by NM, semiotic structure affects cognitive processing.

Inversely, the static naturalness parameters can be transferred to NP: even though proponents of classical Stampean NP were reluctant to accept evaluative dimensions, the reasons that natural phonological processes even occur could hypothetically also be explained in a static manner. Accordingly, the reason for the assimilation of /s+d/ to either [zd] or [st] could be stated in terms of parameters. While it is not my intention to describe how this could be done in detail, I want to stress that in Naturalness Theory, every phenomenon can be analyzed from a static and a dynamic perspective. When children invert the basic shape |J| in literacy acquisition, this can be treated as a natural process that occurs due to the cognitive difficulty of processing that in a system of rightwards-oriented shapes which are also oriented in the writing direction (cf. Section 3.2.2.1), one shape faces left. This same challenge could also be formulated in terms of a parameter: orientation towards the left or in the writing direction is less natural in Roman script than orientation towards the right. This does not yet reveal the level at which the naturalness of this parameter is located (the system-independent, typological, or system-dependent level), and only a comparison with similar phenomena from other scripts will show that it indeed appears not to be the rightward orientation or an orientation in the same direction as the statistical majority of basic shapes in a script, but being oriented in the direction of writing that is most natural for children at this stage (cf. Section 3.2.2).

Building on this brief introduction, Section 3.3.1 is devoted to in-depth analysis of how the naturalness parameters of NM and specific parameters such as *unit of representation* can contribute to an evaluation of the linguistic fit of writing systems by discussing examples from various systems. Section 3.3.2 will then deal with the question of how these parameters affect processing. Both of these endeavors will highlight the specificity of writing as a subject to be treated by Naturalness Theory.

3.1.2.4 Methodology and evidence

There is no real clear-cut methodology that can be extracted from the theoretical framework of Naturalness Theory. However, one methodological aspect is undeniably central to the approach: the consideration of external evidence. I will now discuss how different types of evidence can

[275] I thank my 4-year-old nephew for this example.

be used to uncover natural features in scripts and writing systems. The most crucial types of evidence in Natural Grapholinguistics were already relevant in NP and NM: (1) acquisition, (2) mistakes/errors, (3) disorders, and (4) change (cf. Watt 1975: 297).

In (1) the acquisition of a first writing system, referred to as *L1WS acquisition* (cf. Cook & Bassetti 2005), the central question is: which features and structures of writing do children acquire first or relatively early when they learn to read and write? This question must be treated differently than the question of the sequence of acquisition of linguistic elements and structures – phonemes, morphemes, syntactic structures etc. – in L1 acquisition. As was discussed in Section 1.1.1, language is – in the prototypical case – "inborn" in the sense that it seems to require no extreme and straining effort for children to acquire. Writing differs in that it is taught and learned in the form of instruction which, in turn, is determined not only by the individual teacher but top-down by the government in the form of curricula. The ontogeny of language and writing differs in fundamental ways. Because it is determined externally, the order in which children acquire grapholinguistic elements and structures cannot be readily regarded as particularly insightful. 'Acquire' and 'master' are two different things, however, and the order in which children *master* certain features of writing is, by contrast, revelatory.

With respect to the possibility of a natural form of literacy acquisition, it must be noted that some children acquire first rudimentary knowledge about writing before they are instructed. In Anbar's (1986) study, for example, six preschool children from different backgrounds and with varying IQs learned to read without being formally instructed, and their individual processes of reading acquisition exhibit significantly similar patterns. Making an interesting terminological choice, Anbar believes this finding indicates "a *natural* process taking place in the reading development of preschool children who grow up in a particularly literate environment", with *natural* meaning "that this process is neither directed nor guided from outside the child by the parents or by some standard reading method, but rather develops within each child as a result of something internal to him or her" (Anbar 1986: 78, my emphasis). Thus, *natural* is equated with 'acquired without instruction'. In Section 3.2, in the context of a Natural Graphetics, I will discuss what children learn about writing before they receive formal instruction.

A type of evidence that is closely tied to literacy acquisition is the (2) analysis of mistakes, and not only mistakes made in acquisition but mistakes in general. This type of external evidence is also referred to as *mistake and error linguistics*. For this type of evidence, studies are conducted not only on mistakes and errors (two different concepts, cf. Section 1.3.3) of children but also on those of healthy as well as impaired adults. Furthermore, a broader definition of *error* also includes conscious choices that deviate from the orthographic standard: examples are the omission of punctuation or, especially in German, but also other alphabets with a case distinction, the neglect of rules pertaining to capitalization. These deviations, by the way, can also be considered natural graphematic processes, specifically lenitions.

Evidence that can also reveal naturalness in writing is the analysis of how aphasics or, more generally, people suffering from (3) disorders of written expression and reading deal with reading and writing (cf. Reitz 1994; Gregg 1995; McCardle et. al 2011). The broadest hypothesis taken from Naturalness Theory is that stable elements which are retained despite these impairments are considered more natural than those that are affected by them.

Another central type of evidence is (4) change, or more generally, the development of writing systems which is "relevant to understanding the differential cognitive demands of language and reading" (Perfetti & Harris 2013: 297). As it is one prediction of Naturalness Theory that systems tend to eliminate unnatural features, changes as well as developments in scripts and writing systems will likely reveal more about the features that are natural. As was discussed in Section 1.3.4, a point about Naturalness Theory that is often misunderstood and, consequently, adamantly criticized is a teleology that is ascribed to it and that is said to claim systems change to become more natural in order to arrive at an "ideal" state. This, however, is logically impossible. Change – and this is true not only for language, but for scripts and writing systems as well – "is local and not global because of goal conflicts which characterize all functional systems; [...] owing to the tendency of each component of grammar to increase its own naturalness, markedness reduction on one level usually brings about markedness increase on another" (Bertacca 2002: 9). If, for example, the basic shapes of Arabic script change such that they become increasingly similar, which results in a very unnatural decrease of distinctiveness for the reader, the reason for this might be a primacy of production over a critical period of time and the fact that similar basic shapes reduce the number of motoric programs a scribe must memorize (cf. Section 3.2.2.2).

Writing occupies a special status, as it can itself serve as external evidence in the investigation of the naturalness of phonology and morphology (cf. Zwicky 1973: 88). Writing is always an analysis of the underlying language system, and, on this basis, an analysis of which features of language manifest themselves in writing and which do not is sometimes utilized as evidence for what is natural in language. This, however, is a crucially different question than the one Natural Grapholinguistics is interested in. Here, the question "what is natural in writing?" is at the center and not the question of how the structures observable in writing point to naturalness at other levels of language.

3.2 Natural Graphetics

Natural Graphetics is the subbranch of Natural Grapholinguistics that deals with naturalness in scripts. Scripts are defined as visual systems, systematic inventories of basic shapes. Mainly, they are used glottographically to materialize writing systems, but they can also be used non-glottographically, e.g. for mathematical notation. Natural Graphetics is not concerned with the graphematic functionalization of scripts, but instead only with their material form and everything that it entails from a naturalist perspective. As anticipated above, this subchapter is divided into three parts: the first part assesses the (1) *systematic fit* of scripts. This boils down to the question of how coherent scripts are graphically and visually, i.e. how their features are distributed throughout the individual basic shapes. Is there a large degree of uniformity among the units of a script or are there many outliers and exceptions? The second part of this subchapter is simultaneously its heart. It evaluates the (2) *processing fit* of scripts as it investigates which features play a role in the processing of scripts by humans – and *why* they do so. Based on various studies, I will discuss which features of scripts appear to be productionally, perceptually, and cognitively crucial and describe what their most natural configurations are. Finally, the third part of this subchapter will delve into the (3) *sociocultural fit* of scripts. How do cultural, sociopragmatic, political, technological and other factors influence the makeup of scripts and, in turn, which features of scripts mark them as particularly suited for a given sociocultural context?

3.2.1 Systematic fit

ABCDEFGHIJKLMNOPQRSTUVWXYZ

Aϟשᛯξ 语 ฌ٦ض∀한 ᏕᏜЭ⊦力 ʘ᥀ᗷᐯཀསᏇಿـ ङ

Above, two sets of 26 basic shapes each are presented. One of them is a system, the other is not. One of them consists of visual shapes that share a number of features, one of them is a random selection of visual shapes from different systems. It is likely that even non-literate people unfamiliar with Roman script will regard the first set as the more systematic one. Indeed, studies have found that children who are not yet literate early on reject as writing shapes that are visually dissimilar from the shapes of their own script (cf. Section 3.2.2). The aspects that account for this perception of a coherent system are subsumed under the notion of *systematic fit.* Scripts are visual systems: sets of units with relations between them. Roman script as presented in the first line above, but also Chinese script, the kana scripts of Japanese – all of these graphic (in production) and visual (in description and perception) inventories can be investigated independently from the linguistic structures they are employed to represent. If studied in this purely descriptive manner, the visual properties of scripts come to the forefront, and more specifically, the question of how these properties are distributed throughout a given script. For example, whereas most of the uppercase basic shapes in Roman script are either vertically symmetrical such as |M| or face rightward such as |R|, there is one outlier facing leftwards: |J| (see below). Primus & Wagner (2013: 45) call such outliers whose features do not conform with the features of the statistical majority of a script *non-canonical*, whereas basic shapes that do conform to a script's features are *canonical.* With respect to the orientation of the coda (if there is a coda), aside from |J|, the uppercase basic shapes of Roman script are entirely systematic, i.e. canonical. The systematicity of a script not only has an effect on how it is processed (Section 3.2.2), but, crucially, is likely constituted by how it is processed. This underlines that even though scripts are analyzed descriptively here, the fact that they are not systems which have emerged independently, but man-made systems, must always be kept in mind. In this vein, Watt (1979: 31) claims the systematicity of scripts can "be traced to that property of the human mind, ultimately the human brain, that forms systems in the first place". In other words, it is this property of human brains that did not only enable the invention of scripts in the first place but that also led to their increasing systematization. As the forces involved in the man-led change of scripts are governed by processing needs, they will be discussed in the following section. This section is focused on inherent properties that make a script a system.

To introduce the systematic fit, I want to reconsider and modify an example from Watt (1983a). In order to describe a system consisting of four basic shapes, two features with two values each, i.e. two binary features, are necessary. Watt determines this with the help of the formula $V^F=N$ (cf. Watt 1983a: 384), where V is the number of feature values, F is the number of features and N is the number of basic shapes that the features and their values can generate. If the binary features, as in Watt's example, describe the codas of the basic shapes and are [±cardinal] and [±top], this generates a total of four basic shapes for the inventory (cf. Table 7). In this case, the possibilities that the features and their values offer are exhausted. This means that there exist no additional possible systematic basic shapes that conform to the features of this script which are not already part of the script. In other words, there are no systematic gaps, there is no redundancy in the system (for the relevance of redundancy, cf. Section 3.2.2). Furthermore, there are no exceptions such as |J| in Roman script.

Table 7: Complete system

				
± cardinal	+	+	−	−
± top	+	−	+	−

Table 8: Incomplete system with systematic gaps, which equals a complete system

	complete system								
	incomplete system						*systematic gaps*		
									
± cardinal	+	+	−	−	−		+	+	−
± top	+	−	+	−	−		+	−	+
± right-oriented	+	+	+	+	−		−	−	−

In Table 8, an additional basic shape has been added to the system. Obviously, this shape deviates from the others with respect to the orientation of its coda – like |J|, it is an exception. For the description of this inventory of five basic shapes (cf. the inventory titled 'incomplete system' on the left of the grey column), according to the formula, two binary features do not suffice. With three features, the formula changes to 2^3=8. While this provides enough features to adequately describe the five basic shapes, it has other consequences as well: it produces three systematic gaps, which are positioned in the rows right of the grey column. These systematic gaps represent well-formed basic shapes that, however, are not part of the system. A system without such gaps, i.e. a system in which all of the possible well-formed basic shapes are actually members of the script, is a *complete system*,[276] whereas a script with gaps is an *incomplete system*. This explains why |√|, just like |J|, remains an outlier: it is the only basic shape in this inventory with the value [−right-oriented]. The other possible shapes with this value are systematic gaps. This makes it not just the only shape that deviates from the others in this regard, but also the only shape for which this feature is even relevant. If the three systematic gaps positioned to the right of the grey column were actually members of the inventory, the system would be complete again, and this would equal the most natural systematic fit. No redundancy would exist in the system. Consequently, the graphetic solution spaces for the individual basic shapes are very restrained. Deviations more easily lead to the production of another existing basic shape than in a script with systematic gaps.[277] This situation is natural for the descriptive systematic fit but unnatural for the processing fit. Examples for scripts that appear rather systematic are Cree script and Korean Hangul script (cf. Figure 28 and Figure 29).

As will be shown in the discussion of the processing fit, a completely natural systematic fit is deleterious for the cognitive natural process of misremembering. If one feature value of a basic shape or one of its elementary forms is forgotten (such as the orientation of the coda in |d|) and therefore substituted ("misremembered") with the wrong value, namely the value that predominates statistically in the script or is more natural for other reasons (e.g. [+right-oriented]), the process results in a different basic shape |b| which actually exists in the script and – in this case – is even part of a different graphematic relation. Redundancy in the system would, in the case of misremembering, lead to basic shapes that are not part of the system, i.e. systematic gaps. They would still be mistakes, but they would not evoke wrong graphemes. The fact that redundancy is important for the processing fit should be kept in mind in the (rare) instances in which new scripts are created from scratch. Redundancy, however, should not be misunderstood as *exceptionality*: the feature value [−right-oriented] in the basic shape |J| of the Roman script is not redundant, but an exception. For redundancy, a few more of the twenty-something basic shapes would need to be oriented toward the left, not just one. This would make the feature value a part of the system but would still leave systematic gaps. The distinction between exceptionality and redundancy is, thus, gradual rather than absolute.

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[276] It is a complete system because it is maximally systematic. Note, however, that this does not make it a *closed system*: new units can be added to such a system, making it – in most cases – an incomplete system again as the added units cannot exhibit the existing systematic features of the system, since these are already fully realized. This means that additional basic shapes inevitably introduce new features. If these new features are fully realized by a range of new basic shapes and there are, again, no systematic gaps, the system has become complete again. In this sense, no script is ever "closed" in the sense of closed systems. Scripts are always open systems, even if nowadays, new units are rarely – if ever – added.

[277] Consider, once again, the example of |T| and |Γ|. In Roman script, the graphetic solution space for |T| is larger since |Γ| does not exist in the script but is instead a systematic gap. In Greek script, both basic shapes exist, which means the graphetic solution spaces for both are constrained to avoid misidentification (cf. Figure 15).

Figure 28: Selection of basic shapes from Hangul script, from: http://www.decodeunicode.org/en/u+11FF (February 9th, 2019)

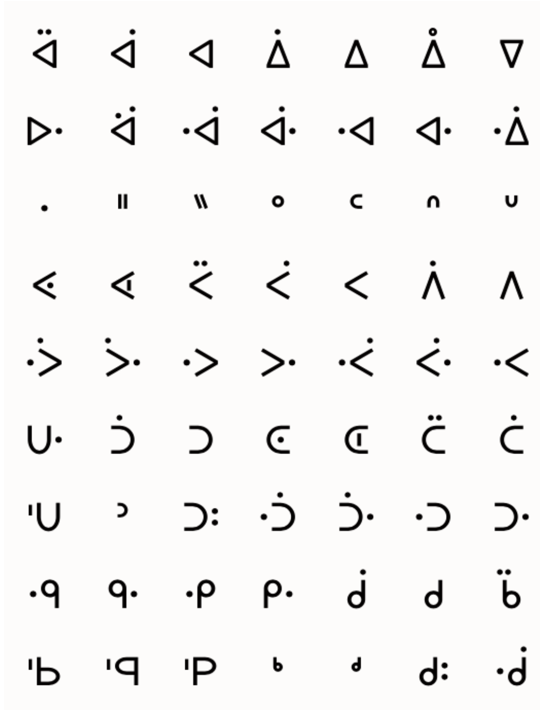

Figure 29: Selection of basic shapes from Cree script, from: http://www.decodeunicode.org/en/u+14FF (February 9th, 2019)

A phenomenon that the systematic fit can help explain is the addition of new shapes to an existing script which are made to "fit" that script. These additions are, probably, in most cases not done with the systematic fit (as defined here) in mind, but still, they are constrained by it. When the uppercase version of |ß| was added by the *Council for German Orthography* in 2017, it was designed to be (a) similar to the existing lowercase version it is based on and paired with and (b) similar to the other uppercase basic shapes: |ẞ| (for a discussion of the criticism of this shape, cf. Section 3.4). In the future, an *a priori* analysis of the systematic fit of an existing script can guide the design of new basic shapes for it.

The systematic fit is not concerned with evaluating the naturalness of individual features such as the above-mentioned [±right-oriented]. The descriptive methodology offers no heuristics for deciding which features are descriptively more natural than others. Whether the basic shapes in a script are orientated towards the right or towards the left, thus, is not of interest for the systematic fit, whereas it is for the processing fit. To recap, the systematic fit deals merely with the visual (in this case this means featural) coherence within a script, its "degree of systematicity" (Watt 1983a). Thus, what must be achieved before the systematic fit can be evaluated is a description of features that answers the question: What exactly are features of basic shapes and how can they be described?

The visual segments of basic shapes, i.e. the smaller subsegments they are composed of – lines, curves, dots – are termed *elementary forms* (cf. Section 2.2.1.2; for an extensive review of attempts to arrive at graphetic elementary forms and features, cf. Meletis 2015: 50-79). It is of paramount relevance for the evaluation of the systematic fit to acknowledge that these elementary forms are not themselves features. This was assumed by, among others, Althaus (1973), who conceived of the vertical stroke and the curved stroke in |P| as two features. An analysis of this kind leads to problems in the featural description of basic shapes, which was most vocally expressed by Watt (1975: 303-323). Watt argued that two types of underdifferentiated featural analyses are ultimately doomed to fail: (1) analyses, such as Althaus's, that assume the elementary forms are the features, and (2) analyses such as Gibson et al.'s (1963) that assign visual features such as [+curved] to entire basic shapes rather than elementary forms. The first type of analysis is not so much inherently inaccurate as it is uneconomic: assuming that |I| and |—| are different features neglects the fact that they are, essentially, realizations of the same elementary form. They only differ in orientation, which is what should be conceptualized as a feature. The elementary forms |C| (itself also an independent basic shape) and the left-facing coda in |q| are also the instantiations of the same elementary form. However, they differ in size and, related to that, in the position they occupy in the segmental space (cf. Section 2.2.1.2). The second type of analysis is underspecified, too: assigning features such as [+curved] to whole basic shapes such as |P| is problematic since it is not the entire basic shape that exhibits this feature, but only one of its elementary forms. Such an analysis fails to offer any tools that further specify which part of a basic shape a feature actually applies to. In an attempt to eliminate the shortcomings of these two types of analyses, Watt (1980: 8) uses linguistic levels as an analogy to describe how he interprets letters (or more generally, basic shapes) as analyzeable units:

> Letters are morphemes because the units of the next level coöccur in sequence, which in turn is so because any solution that directly factors letters in simultaneously-coöccurring units, or features, suffers severe flaws.

The resulting assumption of a hierarchy *basic shape* > *elementary form* > *feature* unfortunately does not solve all the remaining problems of a description of features. The following questions that must be answered for every script: which are the relevant elementary forms occurring in the shapes of the script, and which are the relevant features? Unlike listing the set of basic shapes of a script, listing elementary forms and features is not trivial.

Watt proposed a number of features for the uppercase basic shapes of Roman script as listed at the outset of this section. In two contributions, he investigated the different features relevant in production processes, or, as he calls it, *composition* (cf. Watt 1980), and features that are crucial in perception processes (cf. Watt 1981). This is based on his assumption of two separate competence grammars for production and perception, a kinemic grammar and a phanemic grammar. In line with his arguing, I believe the perceptual features are more relevant for a descriptive account of features since description is commonly based on the static visual datum that is already produced and is the basis for perception rather than the dynamic articulation processes that were involved in its production. The elementary forms of basic shapes, which, when they are produced, Watt calls *kinemes*, and when they are perceived, *phanemes*, have the following perceptual features: [±VRTCL] 'vertical', [±HRZTL] 'horizontal', [±TRACE] 'trace', [±FLNTH] 'full length', and [±CNCVE] 'concave'. These perceptual features are all used to specify individual elementary forms, i.e. lines or strokes. [±VRTCL] gives information on whether a stroke is vertical, as in |I|. [±HRZTL] is the feature of horizontality, as evidenced by the middle stroke in |H| that connects the two vertical strokes. Different from both vertical and horizontal strokes, diagonal strokes are [−HRZTL] and [−VRTCL]. [±FLNTH] informs about the relative length of a stroke, i.e. whether it is, from the perspective of the segmental space, of full length, such as the vertical stroke in |R|, or not of full length, such as the two diagonal strokes in |K|. [±CNCVE] is crucial as it indicates whether a stroke is curved or not: the coda in |P| is [+CNCVE], for example. The use for [±TRACE] is not straightforward, especially in a descriptive (perceptual) analysis. It is the analog to [±TRCE], the productional feature that Watt (1980) had assumed for kinemes that distinguishes strokes that are actually written, i.e. leave a graphic trace, from strokes that are only made in the air when the writing instrument is lifted and moved to the next starting point. These strokes in the air exhibit the feature [−TRCE]. While as a kinemic feature, the inclusion of [±TRCE] makes sense, it is not clear if it is of value as a descriptive feature of phanemes. As Watt's analyses are based on the Roman majuscules used in the English writing system, he assumes two more features: [±HSMTR] for horizontal symmetry and [±VSMTR] for vertical symmetry. With the features named above, the two phanemes in |P| can be described as follows: the hasta is [+VRTCL], [−HRZTL], [+FLNTH], and

[–CNCVE], while the coda is [+VRTCL], [–HRZTL], [–FLNTH], and [+CNCVE]. This analysis into features raises serious questions: is the assignment of these features really absolute in each case? Is the number of features sufficient for the unambiguous description of |P|, i.e. can it distinguish |P| from other basic shapes? In both cases, the answer is no.

In Watt's (1981) analysis, which is much more complex than outlined here as it provides not only a list of features for each basic shape but also a list of rules of how these features are applied and spatially ordered within the segmental space to result in a given well-formed basic shape, the above-mentioned features might have been sufficient to distinguish |P| from the other uppercase basic shapes of Roman script. However, without those highly complex and specific rules, and if the set of uppercase basic shapes were extended to include even only the lowercase basic shapes, the two phanemes described by the above-listed features could also be joined to form |p|, |b|, |q| or |d|, all of which conform to the description of a horizontal full-length stroke and a curved half-length stroke. This goes to show that what is missing in a featural description of basic shapes is information on spatial relations and arrangement. How are the two elementary forms that are specified by these features positioned in the segmental space? Are they connected, and if so, where are they connected and what is the nature of the connection (acute angle, cross, etc.)?

There exist a number of suggestions on how spatial and topological information of this kind could be formalized. I want to present one of them here and discuss how its core ideas could be used to establish a more universal methodology of describing scriptual features. This methodology could then be used to describe the features in the scripts of the world, which is a necessary part of evaluating their systematic fit. The first proposal comes from Althaus (1973). As already mentioned above, Althaus equates elementary forms with features, and he assumes twelve of those features. Where they are located with respect to the vertical axis of the segmental space and over how much of the segmental space they extend is described with the help of seven subspaces, four of which are simple and three of which are complex (cf. Figure 30). These subspaces are based on the vertical subdivision of the segmental and linear spaces in the high, central, and low spaces. Althaus (1973) works with a more fine-grained four-space schema in which the central space is further subdivided into two spaces (in the figure, these are spaces 2 and 3, while space 5 combines the two) (cf. also Section 2.2.1.2). With this type of spatial description, the unisegmental basic shapes |C| and |c| can be distinguished: the former occupies space 6 and the latter space 5. In a formalization, the types of elementary forms are written as digits and the spaces they occupy as superscript digits. The hasta of |P| is formalized as 1^6, the coda as 7^1. The only information that remains unspecified is the order (or spatial sequence) of elementary forms in basic shapes in which there is more than one. Althaus suggests an arrow: a formalization such as $1^6 \longleftarrow 7^1$ suggests that the coda, formalized as 7^1, is located to the right of the head (cf. Althaus 1973: 108).

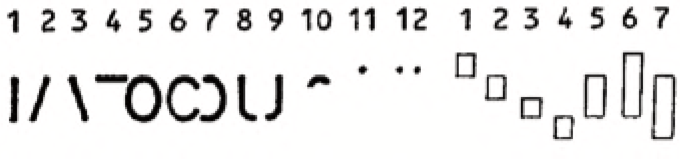

Figure 30: Classification of elementary forms ("features") and spaces they occupy, from Althaus (1973: 108)

The problem with basic shapes and their description is that the elementary forms that constitute basic shapes cooccur. They all exist at the same time and they are arranged in space in complex ways. For a basic shape such as |P|, the description of the spatial relationship between the two elementary forms might not be a complex matter, but for a shape such as |語|, arguably, it is. In his proposal, Garbe (2000: 1769-1771) adopts Althaus's (1973) list of "features", i.e. elementary forms, but conceptualizes the spatial relations differently (cf. Figure 31). Using six division lines (a-f), he divides the linear space into five subspaces (ab, bc, cd, de, ef). These subspaces help formalize the spatial arrangement of basic shapes. |T|, for example, is formalized as:

$\frac{4a}{1ae}$ This formalization is to be read as: elementary form 4 is located on line a, and the fraction bar signifies that it is positioned above elementary form 1 which extends from line a to line e.

Figure 31: A spatial analysis using six lines or five vertical subspaces, from: Garbe (2000: 1769)

If elementary forms and features were kept apart conceptually, Garbe's proposal would represent a promising start for a both featural and spatial analysis of the basic shapes of Roman script. A number of other attempts (cf. Bhatt 1988; Herrick 1966) are very similar in nature. Note that what is missing from these conceptions is the description of connections. They treat all connections between elementary forms as equal, i.e. angles such as |L| and |T|, but also crossings as in |X|. It has been suggested that these connections differ with respect to their complexity (cf. Altmann 2004), which renders any featural analysis that does not account in any way for these differences incomplete and unspecified.

After having highlighted that a featural description of the basic shapes of a script is a necessary prerequisite for the evaluation of the systematic fit, I do not want to propose or prescribe a method of description. I do believe attaining a universal method of describing basic shapes is difficult, but not impossible. It is obvious that the vast visual variety exhibited by the scripts of the world greatly complicates this endeavor. One question that should be put forward for discussion, however, is whether a formalized description such as Althaus's or Garbe's is even necessary. Instead, it could be claimed that a basic shape itself, such as |T|, as a visual datum, is not just a basic shape, but already its own description. This might appear odd, but consider that in the word de*script*ion we can find the Latin word *scrībere* 'to write'. Hence, is it necessary to de-scribe something that is already written? I am afraid it is. Even if basic shapes already were their own descriptions, there would still exist a need for a vocabulary to express how different shapes are similar and how others are distinct and why precisely we perceive a script as a visually coherent system. These questions lead back to square one and the necessity of a method of featurally and spatially describing the makeup of basic shapes. This is all the more evident when a purely graphetic analysis is elevated to a graphematic analysis, e.g. when the question is asked whether some graphetic features are transparent, i.e. consistently correspond with linguistic values or functions (cf. the analyses in Primus 2004, 2006). In such cases, any analysis that has not identified graphetic features is set up to fail.

Finally, I want to mention a number of variables that crucially affect the systematic fit: the (1) *size of a script*, the (2) *complexity of a script* (defined as the number of features necessary to describe it), and the (3) *frequency* with which individual basic shapes occur in the use of a writing system.

The number of basic shapes in a script is always constrained externally. In the process of the initial creation of a script, it is determined by the unit of representation (phoneme, morpheme, etc.) and the size of the inventory of these units (cf. Chang, Plaut & Perfetti 2016: 67). Usually, what would be expected in this process is that creators of writing systems strive for uniformity (cf. Section 3.3.1.5) of graphemes by creating one basic shape for each linguistic unit that they want to represent graphematically. This would create a uniform grapheme inventory in which the number of basic shapes needed for graphemes equals the number of linguistic units of a given type (phoneme, morpheme, etc.). Note that the situation just outlined is the ideal, albeit rare scenario of script creation. More often, scripts are adopted, and given the rarity with which new basic shapes are introduced to existing scripts, writing systems that adopt scripts have to make do with the basic shapes that the scripts offer. In cases in which there are more graphemes than basic shapes, strategies such as using digraphs or adding diacritics to basic shapes are common. Sometimes, one basic shape is also used for more than one grapheme, which leads to a decrease of naturalness on the graphematic parameter of transparency (cf. Section 3.3.1.4). If the number of basic shapes is greater than the number of needed graphemes, some basic shapes of the adopted script commonly remain unused. In sum, the size of a script is prototypically dependent on the language and writing system that the script was initially devised for. Because of the principle of conservatism (cf. Section 3.2.2) which is partially based on the stability and rigidity of scripts due to the invention of printing, keyboards, typefaces, etc., the number of basic shapes in a script is not commonly influenced by a language adopting the script, even if the script offers too few shapes for the language's linguistic units. Note that one practical application of the systematic fit could be that the identified systematic gaps can serve as models for new basic shapes (see above),[278] if those are in need. This would assure that any basic shapes added to an existing script conform to the features of the script. However, it does not solve the problem of technology, most importantly that new shapes are not yet encoded in Unicode and not ready for digital use.

The (2) *complexity of a script*, defined as the number of features relevant to describe its basic shapes, interacts with the size of a script. The more units there are in a script, the more complex it necessarily becomes, as a greater number of features becomes necessary to keep the basic shapes distinct (cf. Chang, Chen & Perfetti 2018: 438; Treiman & Kessler 2014: 163; cf. Section 3.2.2.3). This corresponds with Watt's (1983a) formula of $V^F=N$. Consider the complexity of the basic shapes of Chinese script vs. the basic shapes of Roman script. In a script with thousands of basic shapes (and hundreds of subsegmental components constituting those shapes), a greater number of features is necessary than in a script with twenty-something basic shapes. Of course, even a fairly compact script, i.e. a script with only a small number of basic shapes, can exhibit "unnecessary" complexity. Thus, hypothetically, even in a script with 16 basic shapes, there could be many more than four constitutive binary features (suggested by $4^2=16$), and the basic shapes could consist of more elementary forms than necessary. That being said, the formula of $V^F=N$ is only a theoretical instrument to assess how many features are *minimally* required for a given number of basic shapes. This does not mean that scripts actually conform to this number. What can be postulated as a more or less rough correlation, however, is that the larger a script, the more featurally complex the individual basic shapes have to get in order to ensure distinctiveness. Note that the quantifiable complexity of a basic shape can also be assessed 'unsystematically', i.e. without reference to features, by classifying and counting the elementary forms that occur in basic shapes (as dots, straight strokes, curved strokes) as well as the types of (non-)connections between them (continuous contacts, crisp contacts, crossings, cf. Altmann 2004).

The third and final variable is the (3) *frequency* with which individual basic shapes in a script occur in the actual use of a writing system. It is determined top-down by the frequency of use of graphemes, which, in turn, is determined by the frequency with which the linguistic units occur that are represented by graphemes. Since statistically frequent basic shapes are logically also used, i.e. produced and perceived, more frequently, they are shaped by an adaptation to the processing needs. This could make them easier to write, although the process of productional facilitation is counterbalanced by the perceptual need for sufficient distinctiveness (see the next section). A different hypothesis is that basic shapes that are used frequently can 'afford' to be more complex (in the sense of consisting of a greater number of basic shapes) since they are more stable in the users' memory, which would mirror morphological suppletion and its interaction with the mental lexicon (cf. Hippisley et al. 2004). Quantitative analyses of

[278] Adding new basic shapes to a script could be more natural than modifying existing basic shapes by adding diacritics (unless these diacritics are used diagrammatically and transparently to represent the same linguistic feature in a number of graphemes, cf. Section 3.3.1.2) since segmental basic shapes are more salient than subsegmental diacritics.

writing systems are scarce, but there exist some studies from the field of quantitative linguistics that suggest units that occur more rarely are more complex, which corresponds to the first hypothesis. Specifically, for Chinese script, it was assessed that basic shapes consisting of a greater number of strokes (cf. Yu 2001; Shu et al. 2003) as well as basic shapes consisting of a greater number of components (cf. Bohn 1998) are used more rarely.

3.2.2 Processing fit

> 'Why is this system this way instead of some other way?' Since the alphabet is preeminently a largely undeliberated product of the human mind any profound answer to such a question must obviously take the form, 'What is it about the human mind that has shaped the alphabet to take the form it has?'
>
> (Watt 1988: 231)

Scripts are man-made artifacts. They were invented by humans with the intention of being used by humans. Unsurprisingly, it is their continuous use by humans that results in an interaction between their shape and human processing needs: since features of scripts influence how humans process them, they are subject to human pressure which can result in a change of these features. Thus, developments in scripts – when they are not determined by sociocultural factors (cf. Section 3.2.3) – depend crucially on how scripts are processed by humans. In this section, I will discuss the features of scripts that are relevant in production and perception, i.e. writing and reading processes, and I will show that unnatural configurations with respect to these features lead not only to diachronic change but also to challenges in emergent literacy acquisition – two of the central types of external evidence.

To explain why scripts change, Watt (1983b) assumes four main forces: (1) *homogenization*, (2) *facilitation*, (3) *heterogenization*, and (4) *inertia*. Crucially, the existence of each of the features of scripts discussed in this section can be traced back to one of those forces. The first two of them are, for Watt, the stronger forces: homogenization includes the strive for economy and systematicity and results in the basic shapes in an inventory growing increasingly similar. It is driven mainly by cognition, more specifically our brain, which, as quoted above, "forms systems in the first place" (Watt 1979: 31). In sum, the force of homogenization strives for an optimal systematic fit (cf. Section 3.2.1) that is achieved by the featural uniformity among the basic shapes of a script. Cognitive in nature, homogenization is neither predominantly productional nor perceptual, although Watt (1988: 201) claims, in line with his argument that perception is primary to production (see below), that homogenization is mainly a perceptual force since perception is a crucial part of cognition as well as production. Facilitation, as the second major force, is driven by production and makes shapes easier to produce. Broadly put, it strives for production processes that involve less effort. The two remaining forces, the weaker ones, are of perceptual nature and counterbalance the major forces: heterogenization is the opposite to homogenization and ensures that basic shapes do not become too similar to distinguish. Similarity and distinctiveness, thus, are two features of basic shapes of scripts that are in a naturalness conflict, being driven by opposing forces that each is responsible for diachronic processes making basic shapes either more similar or distinctive. Finally, inertia is the most passive of the four forces as it stands for a preference to retain the status quo. It is a fundamental force since it reflects how users generally disprefer and resist changes in the system. This is echoed in the principle of conservatism and the often-described fact that the development of written language lags behind the development of spoken language. Accordingly, the fact that the basic shapes "of many scripts have changed strikingly little over thousands of years" (Treiman & Kessler 2014: 159) is a result of the force of inertia and the conservatism it motivates. The dynamics of these four forces of script change will be relevant in the discussion of the individual features and how they originated.

While graphetic features can be gained deductively by studying existing research on material questions of writing, an inductive list of relevant features of scripts can nonetheless serve as a starting point and as an orientation. Such a list is provided in Treiman & Kessler's (2014) comprehensive account of literacy acquisition. In their impressive work, they describe the "graphic forms" (Treiman & Kessler 2014: Chapter 5) or what they also term the general "surface properties of writing", which represent fundamental features of the graphetic module of writing. These features include the artificiality, two-dimensionality, lack of iconicity (which equals arbitrariness and abstractness) and visual blandness, sequentiality and alternation (i.e. little internal repetition), rectilinearity, discreteness, and finiteness of writing and its units. In a second step, they discuss the individual "symbol shapes" (Treiman & Kessler 2014: Chapter 8) and – similar to Watt – the "principles that underlie systems of symbol shapes", i.e. principles that underlie the makeup of scripts, such as economy, conservatism, beauty, expressiveness, similarity, and redundancy. Crucially, they discuss how literacy acquisition is affected by them. Treiman & Kessler's collection of features and principles lends the following subsection its basic structure.

3.2.2.1 Graphetic features relevant in processing

Artificiality, arbitrariness, abstractness, and visual blandness

The first feature of scripts and writing in general to be discussed here is *artificiality*. Scripts are artifacts, which means they are artificial. How the artificiality of writing can be reconciled with Naturalness Theory has already been discussed in detail in Section 1.1.2. In this section, the focus is rather on the question of how artificiality interacts with other features of writing and how children learn that writing is artificial. An example that Treiman & Kessler (2014: 105) mention as helping children learn about the artificiality of writing is the fact that it not intrinsic to a given surface, unlike, for example, the stripes of a zebra. In general, children can observe that writing does not appear on "natural" (in the sense of genetic naturalness, cf. Section 1.1) surfaces such as cats or leaves. Furthermore, in their environment, children usually witness the production of writing, for example when they see their parents write shopping lists. Before the age of 2, children start using verbs such as *make* or *write* when referring to the writing process (cf. Robins et al. 2012), which illustrates that they have grasped that writing is man-made. Other features of writing that are closely related to its artificiality are the arbitrariness of its shapes as well as their abstractness. These, in turn, are closely connected to what could be termed the "visual blandness" of writing, the fact that it should not "shout", i.e. should not draw attention to itself. Instead, writing is meant to become invisible behind the linguistic content it conveys (cf. Strätling & Witte 2006: 8), which differentiates it from drawing. Thus, the graphetic module is relegated to the background, which allows the functions of the graphematic module to come to the forefront.

Arbitrariness, in this context, equals non-iconicity, and more specifically, in the case of writing, the lack of pictography or *non-pictoriality* (cf. Lavine 1977: 90).[279] The scripts of the world are largely non-pictographic. Iconicity, here, is not to be understood in a linguistic sense (in which it will be discussed in Section 3.3.1.2). At this point, the iconicity of a pictographic Chinese basic shape that bears a visual resemblance to the meaning of the morpheme it represents is not of interest. Rather, iconicity can also be understood in a different, non-linguistic way in which it surpasses language, which is evident from the processes of literacy acquisition: at an early stage, when children recognize graphic shapes as resembling certain objects, they do not understand that the graphic shapes represent language. They interpret the shapes as directly representing the referent. Accordingly, arbitrariness or lack of pictography at the graphetic

[279] It is necessary to specify that while writing is largely non-pictorial or non-pictographic, it is not entirely non-iconic as there are different types of iconicity. Pictography equals *imagic iconicity*, which writing, from a synchronic perspective, exhibits only to a small degree. However, there is also *diagrammatic iconicity*, also referred to as diagrammaticity, which is not uncommon in writing systems (cf. Section 3.3.1.2).

level means that the shapes – regardless of the graphematic relations they are a part of – do not resemble anything found in nature. As Treiman & Kessler (2014: 171) note, arbitrary and abstract shapes are difficult for children to acquire since they are unfamiliar to them. The authors argue that some basic shapes *are* in fact familiar to children, such as |O| which children know as a circle or |X| which some might know from playing tic-tac-toe. These familiar shapes might be easier to learn and memorize than shapes that children cannot associate with anything. Interestingly, this observation corresponds with the findings of a large study of Changizi et al. (2006) which showed that the basic shapes in the scripts of the world[280] exhibit topological configurations and connections that can also be found in natural scenes. This is also in line with Dehaene's (2009) *neural recycling hypothesis* which claims that the human brain repurposed a number of areas for the reading process which were originally (and still are) responsible for other tasks. In this vein, mechanisms of object recognition are exploited in the recognition of the basic shapes of scripts, which explains the fact that under human pressure, basic shapes evolve to resemble visual configurations of objects witnessed in nature or, more generally, the environment of humans. This line of reasoning fits the larger naturalist hypothesis that human processing pressure shapes the scripts and writing systems of the world.

Figure 32: Increasing abstractness of Chinese script from left to right, from: https://i1.wp.com/saypeople.com/wp-content/uploads/2012/06/Some-pictographs.gif (February 9th, 2019)

Aside from the reflection of junctures witnessed in natural scenes, the basic shapes of scripts are predominantly abstract. This is motivated by the force of facilitation and the principle of economy: abstract shapes can be designed to be easier to produce than more elaborate pictographic shapes which resemble the form of real-world referents. It is noteworthy that with respect to this feature, phylogeny and ontogeny share remarkable similarities: in the course of the development of the writing systems of the world, the scripts employed became increasingly abstract and lost their pictographic character. Take Chinese: Figure 32 illustrates the increasing abstractness in the diachronic development of its basic shapes, which results in a synchronic state of the script and writing system that exhibits only little iconicity of this kind (cf. Xiao & Treiman 2012). This is reflected in ontology in the fact that when children are asked to *write* (vs. to *draw*), they usually do not produce recognizable drawings (cf. Gombert & Fayol 1992). In literate communities, children learn to differentiate between writing and drawing before the age of 3, and their own attempts at writing are much less iconic than their drawing (cf. Treiman

[280] In a first group, the study investigated 96 scripts that are used for non-logographic writing systems as well as, in a second group, Chinese, nonlinguistic symbols, trademarks, and children's scribbles (cf. the criticism in Daniels 2018: 152).

& Kessler 2014: 114; cf. Otake, Treiman & Yin 2017). It appears that for them, in perception and categorization, "pictoriality is perceived as a sufficient criterion for nonwriting status" (Lavine 1977: 92).

Treiman & Kessler (2014: 116) note that the visual makeup of writing distinguishes it from other visual systems, which makes it possible for children to differentiate it from these other systems. At a more sophisticated stage, this same skill – recognizing the systematic fit of scripts (see above) – allows children not only to tell apart writing from non-writing, but also to distinguish between different scripts, i.e. subcategories of writing. Between the ages of 3 and 4, children accept as 'writing' basic shapes that exhibit the general features of the script they have been exposed to primarily (cf. Treiman & Kessler 2014: 168) and reject as writing basic shapes that are not part of this script. In her study, Lavine included three different classes of basic shapes: class I consisted of basic shapes from Roman script, class II were basic shapes that shared some features with Roman script (e.g. some basic shapes from Hebrew script) and class III included basic shapes (from scripts such as Chinese or Mayan) which were to a remarkable degree visually dissimilar from Roman script. Her results showed that even the youngest children (age 3) rejected basic shapes of class III as writing (cf. Lavine 1977: 93). The differentiation between basic shapes from class I and class II proved more difficult, and only 5-year-olds significantly preferred basic shapes from class I. Lavine (1977: 94) concludes that "it is the general features shared by members of the conventional set that are first picked up by children". Thus, when foreign basic shapes, e.g. shapes from Hebrew script, share salient general features with Roman script, which is the script the children had been exposed to predominantly, the children's identification of Hebrew shapes as writing is not surprising. Ganopole's study yielded similar results, as 62 % of 3-year-olds rejected geometric figures as writing. With increasing age, the ability to distinguish Roman basic shapes from numerals and geometric figures advanced, and 5-year-olds were able to differentiate between shapes of all of those categories (cf. Ganopole 1987: 430). The studies of Treiman et al. (2007) and Levy et al. (2006) are congruent with this, with the latter finding that 4,5 is the age at which children are able to distinguish between basic shapes of their script and foreign scripts at above chance level. A number of studies examined the same phenomenon for Chinese children and found that they are able to distinguish Chinese basic shapes from other types of basic shapes (Roman script, Kannada script) or pictures above the level expected by chance (cf. Qian et al. 2015; Zhang, Yin & Treiman 2016).

The features characterized so far – artificiality, arbitrariness, abstractness, visual blandness, and systematicity – are governed predominantly by the principle of economy (Treiman & Kessler 2014: 153-159) which itself is a result of the forces of facilitation and, to some degree, homogenization.

Two-dimensionality, rectilinearity, and directionality

A central feature of writing is its spatiality, and more specifically, its two-dimensionality. Writing exploits the two dimensions not randomly and in a chaotic fashion, but in a rectilinear manner. The feature of two-dimensionality is not fundamentally motivated by any of Watt's four forces but instead by the inherent materiality of the writing surface: writing, as a product of graphic activity, extends in space. It can do so reasonably only in two dimensions, as one-dimensional writing would merely equal a straight horizontal or vertical stroke. On the other hand, the feature of rectilinearity is based in perceptually cognitive constraints: producing basic shapes – which, in a next step, are used to represent linguistic units – on a writing surface in a chaotic way, i.e. positioning them not along a line but randomly on the page, would greatly complicate writing and, even more so, reading processes. Laying writing out linearly, by comparison, facilitates these processes. Children learn about this basic feature of writing early on and tend to reject displays of writing in which units are not arranged along a line. In Ganopole's study, 87% of tested 3-year-olds already claimed strings of graphic material that were not arranged along a horizontal line were not writing. However, the 3-year-olds could not explain their rejection of such displays, whereas older children offered explanations such as "It doesn't go the right way" or "It's got to go straight" (cf. Ganopole 1987: 426f.). Similarly, Lavine (1977: 92) found that children perceived linearity as a feature of writing as linearly arranged shapes were judged as writing much more often than nonlinear arrangements. This general finding was reproduced and further specified by Treiman et al. (2007: 1466f.) who showed that US children younger than 4 years rejected nonlinear arrangements of personal names written in uppercase shapes that were scattered randomly on the writing surface. Among the linear arrangements, all children – including those who, in a prior reading task, could not read any of the words presented to them – preferred the horizontal arrangement over other linear (e.g. vertical) arrangements. Furthermore, the authors found that none of the children preferred vertical arrangements (which actually occur in some writing systems, see below) over diagonal arrangements, which do not occur in any writing system of the world. They concluded that the *differentiation hypothesis* (cf. Tolchinsky 2003), also referred to as the *universal-to-specific hypothesis*, which claims that universal features of writing are acquired by children before system-specific features, is inadequate (cf. also Treiman, Mulqueeny & Kessler 2015 and their findings), as the hypothesis would expect vertical arrangements to be universally preferred over diagonal arrangements.

Writing is not just linear, it is also oriented in one direction, and *directionality* (or *vectoricality*, cf. Brekle 1994c: 136) is a crucial feature in the study of graphetic naturalness. While the features of two-dimensionality and rectilinearity render writing linear, they do not prescribe a direction, and indeed, in the writing systems of the world, multiple writing directions exist. Among horizontal writing systems, many are written from left to right (such as all the alphabets using Roman script), some are written from right to left (such as Arabic and Hebrew). Among vertical writing systems, some write in vertical top-bottom columns from left to right (such as Mongolian) and some from right to left (e.g. Japanese, Chinese). The specific direction of a given writing system seems to be acquired by children first in perception and then in production: for example, in their study, Tolchinsky-Landsmann & Levin (1985: 329f.) found that the majority of 3-year-olds did not produce writing in a consistent direction. Interestingly, some children switched the direction of writing each time they reached the physical boundary of the writing surface and produced an arrangement known as *boustrophedon*, a directional principle that was used in several writing systems in the past (cf. Coulmas 1996a: 49; Figure 33). Among the 42 Hebrew children who participated in the study, children from the age of 4 had acquired the unidirectionality of writing. However, the conventional directionality in Hebrew, right-to-left, was only grasped by children from the age of 5 (cf. Tolchinsky-Landsmann & Levin 1985: 336).

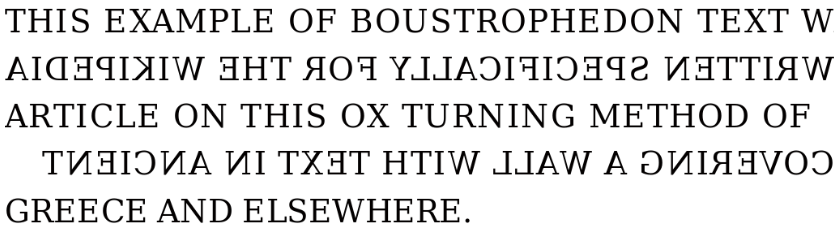

Figure 33: A writing strategy referred to as boustrophedon, from: https://upload.wikimedia.org/wikipedia/commons/thumb/f/fc/Boustrophedon_%28all_caps%29.svg/1024px-Boustrophedon_%28all_caps%29.svg.png (February 9th, 2019)

With respect to vertical directionality, top to bottom appears to be a universal preference (cf. Treiman & Kessler 2014: 111), although, as Clay (1975: 13) observes, "when children were asked to 'Read it with your finger' they moved from left to right, right to left, top to bottom and bottom to top", implying that at some point in literacy acquisition, bottom-to-top directionality is also at least considered as an option. There exists no writing system that is written from bottom to top and it is likely children learn about the universal top-bottom-directionality at a younger age than about the typologically variable horizontal directionality. Directionality crucially affects a number of other features of writing. The most important, I argue, is the spatial and hierarchical organization and makeup of basic shapes. This organization could be termed their *topology*, with one specific subfeature being their *orientation*. While the two-dimensionality and directionality of writing is a *relational feature*, i.e. a feature that is only relevant for a sequence of basic shapes, topology and orientation are *individual features* which can be assessed for individual basic shapes (cf. Section 2.3.1).

A relevant example in this context was already mentioned in Section 3.2.1: the reversal of basic shapes that do not fit the overall visual appearance of a script. Treiman & Kessler (2014: 173) suggest that effects such as the reversal of |J|,[281] the only uppercase basic shape in Roman script that is neither vertically symmetrical (such as |M| or |A|) nor equipped with a coda on the right (such as |R| and |K|), can be explained by statistical learning. In this specific case, the theory of statistical learning holds that children observe and internalize that uppercase basic shapes of Roman script are typically oriented towards the right side. This corresponds with Watt's view of |J| being an outlier among Roman script which, pertaining to the feature of orientation, has an otherwise natural systematic fit. Statistical learning, however, might not be the reason for these reversals, or at least not the only reason.

Clay (1975: 24f.; 64) observed that children, when given a surface to write on, are very flexible in their choice of a starting point. J.-P. Fischer (2017: 534) exploited this by getting children who had previously been exposed to a dextrograde writing system to start writing at the right-hand end of the writing surface. Children were instructed to write their names as "beautifully as possible" and to start writing where the ink dot was positioned. In the "dot-left condition", this dot was located at the right end of the surface, which, due to the directional flexibility of the children, encouraged right-to-left writing. What Fischer observed in the dot-left condition was that children, when writing from right to left, reversed most of the right-oriented basic shapes so that their codas were oriented leftward. This finding calls for a re-evaluation of the so-called *right-writing rule* (RWR, cf. Fischer & Koch 2016) which holds that children "in our left-to-right oriented culture [...] should prefer to orient their writing rightwards when writing the characters from memory". This reasoning, which is in line with the hypothesis of statistical learning, was previously assumed to be the cause for reversals of |J| in conditions of left-to-right writing. In light of J.-P. Fischer's (2017) results, the right-writing rule must be phrased more generally. What is more natural, it appears, is not the production of basic shapes that exhibit the same orientation as the statistical majority of the script's basic shapes, but an alignment of the orientation of basic shapes with the direction of writing, whatever that direction might be. As McIntosh et al. (2018: 680) remark, this "implies that the heuristic that children apply is not that most letters face rightward, but that most letters face in the direction of writing (and reading)". J.-P. Fischer (2017: 538) refers to this as the *writing-direction-orienting rule*. Additional strong evidence for this rule is provided by the fact that even though among digits, there are, with respect to handwriting movements in their production, a greater number of left-oriented digits (|1|, |2|, |3|, |7|, |9|) than right-oriented ones (|6|, |5|, |4|), in the left-to-right writing condition, the left-oriented digits were more often reversed than the right-oriented ones. One explanation that Treiman & Kessler (2014: 170) propose for this observation is that children, for some reason, treat digits and "letters" (scriptual basic shapes) as one set (cf. also Watt 1983a: 381). Given J.-P. Fischer's (2017) results, however, it is more likely that the naturalness of the *writing-direction-orienting rule* overwrites the statistically dominant feature of [left-oriented] among the inventory of digits. With respect to terminology, in line with Naturalness Theory, I would prefer to refer to writing-direction-orientation as a naturalness parameter, not a rule, as rules have the connotation of being learned and unnatural (cf. Section 1.2.2.1).

281 Instances of these reversals can also be found diachronically. One example is archaic Greek lambda which derived from the Phoenician basic shape |✓|. Because all other basic shapes in Greek script were right-oriented, the shape was inverted and became |⟍|. Additionally, since most of the shapes had the coda at the top rather than at the bottom of the basic shape, the shape further changed to |⟋| (cf. Watt 1988: 204).

Additional evidence for this naturalness parameter of writing-direction-orientation of basic shapes comes from diachrony (cf. Jeffery 1961: 43-50). Brekle (1996: 483) postulates that the cause for the dextrograde direction of writing Roman script is not due to an explicit (externally commissioned) standardization of direction, i.e. an orthographic regulation, but due to what I would call *natural scriptual change*. Although Brekle also categorically rejects the idea that dextrograde writing is *per se* more natural than any other direction of writing, he describes a trajectory of stages and changes that illustrate how, successively, users changed and stabilized the direction of Greek script. Thereby, he offers a causal explanation that is precisely in line with the assumptions of Naturalness Theory. Brekle's (1996: 486) reconstruction starts with his assumption of an initial dextral ductus, i.e. dextrograde motoric programs for producing vertically asymmetrical basic shapes. When the Greeks adapted the Phoenician script around 800 BC, this dextral ductus of production did not change, even though the direction of writing was sinistrograde. This means that sequences of basic shapes were written from right to left while individual shapes were internally produced from left to right.

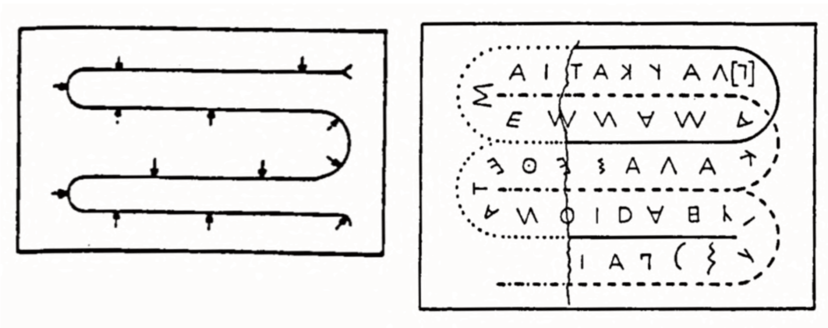

Figure 34: Capovolto writing, from: Brekle (1996: 487-488)

At that time, there existed a scribal practice referred to as *capovolto* (cf. Figure 34). In this snake-like strategy of writing, when a scribe reached the physical boundary of the writing surface, lines were not broken but shapes were first turned 90° and then 180° and reversed not only horizontally, but also vertically. *Boustrophedon* (cf. Figure 33) represented the next developmental step in which the shapes came to "stand on their feet" (Brekle 1996: 487, my translation).[282] This also introduced the concept of line breaks, i.e. successive lines. There exist a number of inscriptions from around 700 to 600 BC that are written in *boustrophedon* in which the direction of writing changed for every line. A possible reason for the variability of direction in successive lines is the practice of writing a line in the same direction in which the profile of a pictured person faced, i.e. in the direction in which a pictured person "looked". Brekle assumes that scribes at the time interpreted the basic shapes as reversible along the vertical axis, which was facilitated by the fact that the majority of them were vertically asymmetrical and their codas could face both directions.

However, *boustrophedon* was cognitively and physiologically unnatural precisely because it required changing the direction of reading and writing for every line. This cognitive unnaturalness led to changes that optimized the above-mentioned naturalness parameter of writing-direction-orientation. These changes can be reconstructed on the basis of Brekle's *hasta-coda-principle*. The visually dominant hastas (in most cases vertical strokes) are accompanied by codas that face the writing and reading direction. The fact that the codas visually (i.e. descriptively) face the writing direction does not necessarily reveal anything about their internal ductus, i.e. the direction of movements involved in their production, as the direction of writing and the internal ductus of producing the basic shapes might be incongruent. Theoretically, this yields four possible combinations of the two variables of *writing direction* (sinistrograde vs. dextro-

[282] „In einem [...] nächsten Schritt wurde das kontinuierliche Buchstabenband bei jeder Kehre ‚abgeschnitten' *und* die hängenden Buchstabenformen um 180° nach oben gedreht, so daß sie auf ihre Füße zu stehen kamen" (emphasis in original).

grade) and *ductus direction* (sinistral vs. dextral): sinistrograde-dextral, sinistrograde-sinistral, dextrograde-dextral, and dextrograde-sinistral. The internal ductus of basic shapes was predominantly dextral. This means that when writing in *boustrophedon*, scribes needed to change their motoric programs for every line: in sinistrograde lines, because of the dextral ductus, scribes first wrote codas and then hastas (= sinistrograde-dextral), while in dextrograde lines, production started with the hasta and proceeded with the coda (= dextrograde-dextral). Gradually, from 600 to 500 BC across Greece and Rome, the dextral ductus led to the fixation of the dextrograde writing direction (cf. Brekle 1996: 489f.). Ultimately, this fixation of the writing direction was determined by the force of facilitation: fixing the dextrograde direction meant that all shapes could be produced with a ductus that was congruent with the writing direction: they could all be produced dextrograde-dextrally.

In accordance with Naturalness Theory, Brekle (1996: 490) cites mistakes of writing found in inscriptions as evidence for the universal preference of writing-direction-orientation: in some inscriptions that followed the *boustrophedon* strategy, in sinistrograde lines, right-oriented shapes appeared. These shapes should have only occurred in dextrograde lines.

Up until this point, individual basic shapes or sequences of basic shapes, lines, and the succession of lines were discussed. It is the succession of lines that most demonstrably underscores the two-dimensionality of writing. The repercussions of the feature of two-dimensionality for grapholinguistics are monumental. In fact, the linearity of writing has, for a long time, been misread as “one-dimensional linearity”, a view that is referred to as the *dogma of linearity* (cf. Krämer 2003: 159). This dogma resulted in the fact that mainstream linguistics excluded any considerations of two-dimensional features of writing (cf. Waller 1991: 346ff.). As established in Section 2.2.1.2, writing makes use of both dimensions, and it does so not exclusively in a linear fashion. At higher levels of organization, not only the succession of lines is of interest, but, for example, also the arrangement of paragraphs or the arrangement of paragraphs and non-written material such as figures or pictures. The latter type of arrangement is generally referred to as *layout* (cf. also the concept of *graphetic dispositif* in Section 2.2.1.2). This layout or “page arrangement” is more difficult for children to grasp than the mere linearity of single strings of writing or lines, and unsurprisingly, it is acquired later. Clay (1975: 39-41) observed that even when children have mastered the directionality of their respective writing system, they run into problems of page arrangement. Figure 35 illustrates that a child may “[adopt] an easy solution and [fill] any left-over spaces with left-over words, ignoring at that moment any constraints of directional principles” (Clay 1975: 39). In this case, there was no empty space left on the page after writing ‘we are going in the’, so the child produced the final word ‘bus’ on the left side of the page where there was free space. Since elements in a layout are arranged not simply on the basis of their materiality, but usually based on their function, the question of page arrangement will be returned to in the context of Natural Graphematics, in particular with respect to the parameter of indexicality (cf. Section 3.3.1.3). Under this perspective, for example, the spatial relationship between the main text and footnotes can be studied, as well as the influence this relationship has on the processing of complex texts containing these classes of elements. This corresponds directly with the principles of Natural Textlinguistics (cf. Section 1.4.2) which deals with the higher-order relationships between texts.

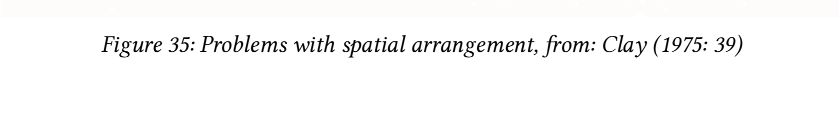

Figure 35: Problems with spatial arrangement, from: Clay (1975: 39)

Segmentality, finiteness, sequentiality and multiplicity, alternation

A fundamental feature of writing is that its units are *segmental* and *discrete*. These features are based on the fact that writing is an analysis of language, and every writing system must choose units of language, whether phonological features, phonemes, syllables, or morphemes, and represent them as written segments. Even if units of writing are graphetically connected, as is frequently the case in cursive writing or, in some writing systems such as Arabic, also in print, users are commonly aware of the segments that constitute larger units of writing. This is one of the crucial differences between writing and speech, as in the acoustic continuum of speech, no segments stand out (*a priori*).[283] Another universal feature of writing is its *finiteness*: every writing system (and script) consists of a finite number of units. This, of course, is another top-down reflection of the fact that the units of writing represent linguistic units. The linguistic units that are represented by the smallest units of writing come from (relatively) closed inventories such as the inventory of phonemes, syllables, or morphemes of a language, but not words or sentences, which are open classes (cf. Meletis in press a). However, only graphemes and basic shapes are finite, graphs are not: when it comes to the actual concrete materialization of writing, visual shapes are subject to a degree of variation that is unprecedented in speech and that can lead to challenges in the modeling of categorical perception.

The segmental and discrete units of writing that are drawn from closed sets are produced in sequence. Accordingly, for something to be considered writing, multiple units need to occur together, a feature that has been referred to as *multiplicity* (cf. Ganopole 1987: 419f; Lavine 1977: 93). In literacy acquisition, children are more likely to classify strings of basic shapes as writing than single basic shapes: they are more likely to accept |PLVN| as writing than just |P| (cf. Treiman & Kessler 2014: 111f.). In her study, Ganopole (1987: 428) showed that across four age groups (English-speaking children aged 3, 4, 5, and 6, respectively), 90% of the children rejected displays of a single Roman basic shape as writing. Strings of only two basic shapes were “troublesome” for many and were rejected “on the basis of insufficient quantity of symbols”. Three basic shapes were more acceptable, while strings of four basic shapes were accepted by all children. By contrast, Lavine (1977: 92) showed that multiplicity was a significant criterion only in the youngest group of children, whereas for 4- and 5-year-olds, it was not. She suggested as an explanation that “for the children as a whole, the unit itself takes on greater importance with age”. This could reflect the fact that in many writing systems, there exist words that consist only of one grapheme, such as the article <a> in English or monomorphemic words in Chinese. This knowledge is expected to be acquired later, at a stage at which the relation between the visual and the linguistic is gradually grasped by the children.

Segmentality as a feature of writing is predominantly constituted by empty spaces between units (cf. Section 2.2.1.2). While empty spaces at all graphetic levels of writing are visually salient, the most salient type is, arguably, the empty space between ‘words’ (for problems with this claim, cf. Section 2.2.2.4). Expectedly, this ‘interword’ space features in studies on emergent literacy (e.g. Tolchinsky 2003: 69; 184f.; Tolchinsky-Landmann & Levin 1985: 324f.; Gombert & Fayol 1992: 38). Children in writing systems with interword spacing appear to perceive this feature as a salient characteristic of writing and use empty spaces themselves, as is evidenced by their own early productions of writing which feature empty spaces. What children have acquired at this stage, however, is only the “surface property” of writing, i.e. a graphetic feature. Children learn about the graphematic function of interword spaces at a later stage when they acquire knowledge about the representational function of writing and metalinguistic knowledge about the unit ‘word’.

Children understand early on that the script they have been predominantly exposed to is a more or less coherent system. This becomes evident when they reject as writing basic shapes

[283] I want to remind the reader again at this point that some scholars claim that the phoneme is no existing segment of speech and that its status as a segment is only an epiphenomenon resulting from alphabetic (or, generally, segmental) writing systems (cf. Faber 1992).

that do not conform to the general features of their script. The question is how and when children understand that a script is a more or less[284] closed inventory. Clay (1975: 31f.) describes how children sometimes tend to make lists of all the basic shapes they know. This behavior could be interpreted as an early awareness of the fact that there is a limited number of units in a script. However, children do not only do this for basic shapes but later on also for written words and sentences, which are open classes. Clay terms this the *inventory principle*. I do not know of any research that has dealt with the question of how children acquire knowledge of the finiteness of scripts, but it is reasonable to believe that the finiteness of scripts is acquired when children understand that the basic shapes are employed for graphemes. Only top-down, then, do they realize that because there is a limited number of sounds (or morphemes, etc.) they can represent with graphemes, there must also be a limited number of basic shapes. While at an abstract level, scripts and grapheme inventories are finite, at the graph level, there is almost infinite variation. It is an obvious assumption that children grapple with this kind of variation and the challenges of categorization that it entails (cf. Treiman & Kessler 2014: 181). In production, children tend to test "how far they can go before a symbol changes so significantly that the meaning is altered" (Kenner 2004: 87), i.e. they experiment with the scope and the boundaries of the graphetic solution space (cf. Section 2.2.1.2).

Usually, a unit of writing is not repeated in immediate sequence very often, making it much more likely that a unit is followed by a different unit than by the same unit. There are exceptions to this, of course, such as the frequent doublets in Finnish or spellings in German such as <Schifffahrt> which were recently orthographically licensed, where the grapheme <f> is written three times in sequence. There is evidence that children acquire knowledge about the lack of internal repetition, which could also be termed *variety* or *alternation*, before grasping the graphematic relations between basic shapes and linguistic units. Even at this preliterate stage, children are more likely to accept strings of basic shapes that exhibit variation, e.g. ABC, than strings in which basic shapes are merely repeated, such as AAA (cf. Ganopole 1987: 428f.; Lavine 1977: 92). They appear to have acquired the knowledge that "adjacent symbols within a string don't normally have the same shape" (Treiman & Kessler 2014: 112). Interestingly, Clay's account, which is, however, qualitative and observational in nature, does not include concise information about the data she collected and lacks any statistical information, includes the assumption of a principle referred to as the *recurring principle*. It holds that a child "who knows only a few letters or words can take a short cut to a long statement by repeating the same symbol again and again and again" (Clay 1975: 21). This does not necessarily contradict the above-mentioned findings. A possible explanation for it is that production lags behind perception and children are able to distinguish a greater number of basic shapes in perception than in production. Whereas the child has probably acquired knowledge about the feature of multiplicity, knowledge of the lack of internal repetition comes only at a later stage. Repetition at an early stage might be a reflection of the fact that children want to produce longer strings of writing even when they do not yet know many units, and "as a self-initiated process repetition can provide a wonderful sense of accomplishment" (Clay 1975: 21). This is in contradiction with newer, empirically grounded findings from Pollo, Kessler & Treiman (2009) who showed that when children randomly produced and combined the basic shapes they had acquired, they produced double sequences of the same basic shape less often than expected.

An interesting study with respect to the repetition of written units is Lehtonen & Bryant (2005) in which 121 Finnish children between the ages 6;5 and 9;8 were tested. Its most relevant finding is that "already at the beginning of the first school year children possessed formal knowledge of doublet use and knew that word-initial doublets are not allowed" (Lehtonen & Bryant 2005: 211). This conclusion is striking as it suggests that even children who have not yet understood the representational linguistic function of writing are already aware of positional

[284] I say "more or less" since new shapes can theoretically be added to scripts, which, however, at an advanced stage of development, when the script has been in use for a long time, is rather seldom the case.

constraints. Interestingly, doublets (such as |aa|) were not generally rejected, only the ones in positions that are not graphotactically licensed in Finnish. Thus, children appear to have acquired a graphematically graphotatic constraint solely through exposition to the graphetic module of writing, before (or on the verge) of understanding that this constraint is determined graphematically. Fittingly, Clay (1975: 22) underlines that when children are older, they must learn about specific constraints of English such as that no more than two graphemes are ever repeated in sequence. This, however, is a genuine system-specific feature of the English writing system rather than a universal graphetic feature of writing.

3.2.2.2 Production

One method of organizing the analysis of graphetic naturalness is to investigate it under the perspective of the central naturalness conflict: the needs of the writer and the needs of the reader. This conflict is encapsulated by Watt's three forces of homogenization, facilitation, and heterogenization, and by Treiman & Kessler's principle of economy. With respect to the actors motivating these forces, homogenization and economy are vague terms. Even though they might imply a purely productional perspective, they are neutral with regard to production or perception. The principle of economy, too, can, on the one hand, pertain to the number of motoric programs that need to be memorized to produce the basic shapes of a script or, on the other, to the number of visual templates (or features) that need to be memorized and identified to recognize them. Homogenization, while ultimately a cognitive force, can, as already mentioned above, also be seen from a perceptual point of view.[285] With respect to the systematic fit of scripts, a central hypothesis holds that scripts with visually homogeneous (but, importantly, sufficiently distinctive) basic shapes are processed by users with less effort than more heterogeneous scripts.[286] Heterogenization, on the other hand, seems to be an exclusively perceptual force, as it ensures that the shapes of a script do not grow too similar to be distinguished as separate units, which, in case it did happen, would require a secondary process of making them more distinctive again, which happened in Arabic script (see below). Finally, inertia, or, in the list of Treiman & Kessler's (2014: 159) principles, conservatism, as the fourth and final force, is not a driving force of change but the inhibitor constraining it. As such, inertia is a crucial force assuring the stability not only of scripts but also of writing systems. In general, writing systems change much more slowly than the language systems they represent, which can lead to the increase of opacity in the relations between the two or, more generally, a decrease of the linguistic fit.

In this section, I will discuss how naturalness is reflected in production and how productional naturalness affects the naturalness of the entire graphetic module. The next section will do the same for perceptual aspects. Notably, productional and perceptual aspects can rarely be separated completely, and crucial interactions will have to be dealt with throughout. What can be stated in advance is that when it comes to natural graphetic processes in production, facilitation is the major driving force. The following paragraphs are focused exclusively on handwriting processes. However, as handwriting, by some regarded as a "forgotten language skill" (Medwell & Wray 2008), is, at least in some literate communities, used more rarely than before

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[285] For Watt (1983b: 1545), homogenization is indeed mostly perceptual, as he states that it "operates mostly on the cognitive phanemic grammar, altering the remembered forms of letters (or, equivalently, the rules for determining the forms of letters)".

[286] For the concrete level of graphs, this hypothesis could indeed be confirmed. In a number of studies, Sanocki (1988, 1991; Sanocki & Dyson 2012) could observe that visual uniformity in the design of individual typefaces – e.g. by means of stroke weight, stroke contrast, and stress angles in the design of graphs materializing different basic shapes – has a beneficial effect on processing. So-called *font regularity* (Gauthier et al. 2006: 555) helps the processing system "[tune] itself to exploit regularities of a font" (Sanocki & Dyson 2012: 133). This 'skill' on behalf of readers is referred to as *font tuning* (Gauthier et al. 2006: 541).

and makes way for electronic, i.e. digital ways of writing, these ways of writing which include typing and swiping must be included in a theory of writing. They will be addressed in the next step.

A central consideration in the facilitation of handwriting is the motoric complexity of basic shapes. This includes the number of elementary forms and the nature of connections between them. However, segmentation of basic shapes is only one part of the production process, as a decision about the adequate order of production of elementary forms must also be made (Thomassen & Tibosch 1991: 269). In general, "writers want shapes they can produce quickly, with little cognitive and muscular effort" (cf. Treiman & Kessler 2014: 153; cf. also Thomassen & Tibosch 1991: 270), which is most often associated with a reduction of elementary forms that basic shapes consist of. This productional aspect of economy, from a diachronic perspective, often simultaneously promotes the cognitively natural homogenization of a script's basic shapes. This, however, simultaneously introduces perceptual ambiguity into the script: as the shapes become increasingly similar, their distinctiveness can, at times, be on the verge of vanishing. Note that this is not a necessary development: productional facilitation merely dictates that the basic shapes become easier to *write*, and the homogenization of motor programs across basic shapes does not necessarily equal homogenization in the corresponding visual shapes. Similar movements need not produce similar shapes. In fact, facilitation might even render shapes visually more distinct as they become easier to produce, although the perceptual part of the force of homogenization appears to constrain this. The interaction between productional and perceptual forces is, in any case, complex.

Aside from the production of individual basic shapes and following the conception of natural processes in NP (cf. Section 1.2.2.1), Natural Graphetics also studies sequences of basic shapes as there appear to exist effects of coarticulation in writing (see below).

An influential model of the processes involved in handwriting is Goodnow & Levine's (1973) *grammar of action*. It describes the sequence and characteristics of children's copying processes. The motoric production processes it captures are said to have a "huge constraining power" (Thomassen & Tibosch 1991: 278). They can be summarized as follows:

a	Start at the top of the pattern
	Start at the left-hand extreme of the pattern
	Start at a vertical segment
b	Draw strokes downwards
	Draw strokes rightwards
c	Thread: continue pen-down
d	Anchor: connect to earlier strokes
e	Draw parallels in immediate succession

(Thomassen & Tibosch 1991: 271)

While one group of these processes is concerned with the *starting point* (a), another group is concerned with *stroke directions* (b), and the final group is dedicated to *stroke sequences* (c-e) (cf. Thomassen, Meulenbroek & Hoofs 1992: 72). Stroke sequences include the central production strategies of *threading*, i.e. continuing to write with the pen on the surface and thereby avoiding to lift the pen when possible, and *anchoring*, i.e. using an earlier, already produced stroke as a connecting point for a successive, connecting stroke and thereby avoiding to start a new stroke in empty space. It is important to note that not all of these processes are universal: "start at the left-hand extreme of the pattern" and "draw strokes rightwards" only apply to right-handed individuals in writing systems with a dextrograde writing direction. The others, however, are expected to apply universally and have been described for the production of, for example, the basic shapes of Roman script (Parkinson, Dyson & Khurana 2010) and Chinese script (Flores D'Arcaïs 1994). These dynamic processes of handwriting imply that *top-bottom directionality*, *verticality*, *continuity*, *connectivity*, and *repetition* are relevant (static) naturalness parameters for Natural Graphetics. Some universally preferred features of basic shapes might be explained by them, e.g. the predominance of cardinal strokes vs. oblique strokes, which could be a result of the preference for a downward direction of stroke production, or the preference for curves vs. angles, which could be a result of threading, and also the preference for connected segments of basic shapes vs. unconnected ones, just to name a few. These features will be discussed below when their relevance for perception will be assessed. It is noteworthy that some of these above-mentioned processes are in conflict with each other: in the production of |E|, for example, the same movement has to be repeated three times (and the parallel production of the three horizontal strokes is economic, per rule (e)), but this repeated movement requires lifting the writing instrument each time, which violates the process of threading (which is unnatural). Even at this local level, thus, naturalness conflicts can be detected.

Research on factors that cause difficulties in handwriting processes is scarce. A recent study by Gosse et al. (2018) claims it "offers for the first time a universal classification of the graphic characteristics of words" by which it "enables the quantification of the graphic complexity of words". The results of the study, in which twenty French second grade children participated, show that the following factors, in order of impact, negatively influenced the *legibility* of children's handwriting: (1) modified links, (2) angles, (3) curves, (4) pen-ups, and (5) length. The only of these factors that had a negative effect on handwriting *speed* was angles.

An example for a (1) modified link is the connection between |b| and |r| in connected cursive handwriting (cf. Figure 36). In the study, modified links caused aesthetic distortions, incorrect size and incorrect relative height of shapes, as well as poor alignment (cf. Gosse et al. 2018: 1201). The authors conclude that some sequences of basic shapes, when realized as concrete graphs in handwriting, require special links that change the shape of individual graphs. From a productional perspective, the fact that distortions suggest that modified links could be difficult for children is astonishing. What would be expected – in analogy to natural phonological processes in NP – is that the process of connecting two graphs in a way that enhances handwriting fluency and does not require lifting the pen is *more* natural than materializing basic shapes in sequence exactly the same way they would be produced in isolation. Imagine a lack of positional allographs in Arabic: regardless of their position within a word, the graphemes would always be represented by the same basic shape. Such a situation would likely be easier to process cognitively, as fewer basic shapes would need to be remembered. However, from a productional perspective, the connectivity of the positional variants allows fluency in handwriting, a benefit that would be lost. In the light of all this, the existence of positional variants furthers the impression that the development of Arabic script was, for a formative period of time, shaped by the needs of scribes rather than those of readers. This primacy of production even led to the visual collapse of a number of basic shapes that subsequently needed to be disambiguated by dots (see below).

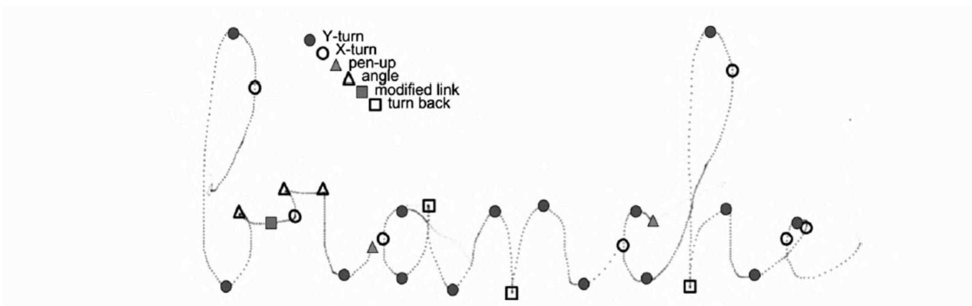

Figure 36: Example of a modified link between |b| and |r|, from: Gosse et al. (2018: 1191)

The fact that in Gosse et al.'s (2018) study, modified links appear to have a deleterious effect on handwriting points to the possibility that written production is fundamentally constrained by perception. Accordingly, the authors name as one possible explanation "that children are taught at school to handwrite the letters of the alphabet in an invariant way, with the shape of the letters expected to be unchanging" (Gosse et al. 2018: 1201). Thus, children acquire not only one motoric program per basic shape, but, crucially, also one visual template. At this stage of the children's development, the pressure to keep the invariant visual template intact in handwriting processes appears to be stronger than the articulatory drive to facilitate hand movements (cf. also Morin 2018: 674). For Watt (1988: 201; 205), "the [motoric, D.M.] program is merely a servant to the [visual, D.M.] pattern" and "the kinemic side of the alphabet exists only to serve (bring into accessible existence) the phanemic side". In agreement with this, Changizi et al. (2006: E120) claim that "human visual signs are selected for vision at the expense of motor". This, together with more evidence discussed below, suggests that in the processing of writing, there actually exists a primacy of perception (cf. also Primus 2006: 10; Watt 1988).

Since the complexity of the visual template that is cognitively stored affects production, different scripts require different levels of productional competence. Chinese children, for example, have to show more pen control than children acquiring Roman script as they "also need to be able to recognise small differences in stroke patterns, to check that they have written each character correctly" (Kenner 2004: 76). The graphetic solution spaces for basic shapes of the Chinese script are much more restricted, which means "a small difference in the stroke pattern can make it look like another character with a different meaning".

The second variable in Gosse et al.'s (2018: 1202) study that caused children problems in handwriting were angles. These generally take longer to be mastered by children. The authors suggest that the cause of this difficulty could be that "changes of pen-stroke trajectory induced by the angles could be more demanding" graphomotorically. Angles represent ruptures in motor programs. While they do not represent *lifts*, as they do not necessarily violate the process of threading and do not require lifts of the pen, they are *stops* (cf. Paz-Villagrán, Danna & Velay 2014). Stops are defined as "any discontinuity in graphomotor activity without the pencil having been lifted off the page and excluding any unavoidable inter-letter penlift" (Bonneton-Botté et al. 2018: 929). 80-90% of stops occur at angles, with stops within a single straight stroke being rare. Curves, which are continuous, are expectedly easier to produce than angles. In fact, in Gosse et al.'s (2018) study, curves on the x-axis (such as in |u|), were even found to facilitate handwriting. This finding is interesting insofar as I listed *roundness* vs. *angularity* as possible base categories for a script typology (cf. Section 2.3.1). These empirical findings suggest that as curves are easier to produce, scripts that consist of basic shapes that are predominantly curved in character (such as Georgian or Telugu) might be easier to write than more angular scripts such as Korean Hangul. Of course, the study in question only evaluated Roman script which exhibits an alternation between curves and straight lines in its basic shapes and is neither predominantly curved nor angular. Studies comparing handwriting processes in predominantly curved vs. predominantly angular scripts are needed to further investigate the hypothesis whether curves – even if there are as many of them as in Georgian or Telugu – are actually facilitating and lead to scripts that are more natural from a productional perspective. The perception of curves, which might tell a different story, will be discussed below.

The productional naturalness of curves is reflected not only in ontogeny and performance, but also in the diachronic development of (some) scripts. Watt (1994c) describes in detail the process of *curvilinearization*, the "rounding off" of angles (cf. Watt 1980: 13). He describes how the development of curves from what were originally angles is due to facilitation of production processes (cf. Watt 1980: 13f.). There is also the opposite development, *angularization*, which raises interesting questions. In this context, runes are a fitting example, as they angularized the curves of Roman script (cf. Treiman & Kessler 2014: 158). Runes were produced on wood, so one hypothesis is that paragraphetic factors – the writing surface, the tools used and the mode of production itself – necessitated the production of more angular forms. This would be an *external* explanation for angularization that does not contradict the fact that, in general, in production, curves are easier to produce. An interesting implication of this that will be discussed below is that this particular paragraphetic production scenario – carving on wood – is less natural than a different one – e.g. writing with a pen on paper – which allows the production of curves. The use of specific materials in a given production scenario might be imposed by other factors – such as, simply put, availability. These factors are treated in the context of the sociocultural fit of scripts (cf. Section 3.2.3). It is important to note that they have the power to overwrite naturalness on the processing level. Another example that might not be as easy to explain is the fact that Chinese script, as it grew more abstract over time (cf. Figure 32), also lost much of its curvilinearity and became increasingly angular.

One of the graphetic features of writing mentioned in Section 3.2.2.1 that is problematic for handwriting is its segmentality. The preference for *threading* in the *grammar of action* already implies it, and studies prove that during writing acquisition, children have a problem with discontinuity, i.e. lifts of the writing instrument (cf. Treiman & Kessler 2014: 154; Gosse et al. 2018: 1202). In children's first writing attempts, they sometimes produce unbroken wavy lines which do not allow a segmentation in separate units. This, as Treiman & Kessler (2014: 111) suggest, might have nothing to do with the fact that children have not acquired knowledge about the segmentality of writing, but instead with the fact that they avoid lifting the writing instrument. One of the consequences of this articulatory preference for continuity for the makeup of scripts is that usually, in basic shapes, the elementary forms connect to each other. Basic shapes such as |Ξ| in Greek script, in which the segments are unconnected, are much rarer in the world's scripts than basic shapes in which they are connected. If such unconnected shapes exist in a script, they are often produced in a continuous way in handwriting (cf. Wang 1958: xxv-xxvi).

An interesting question regarding the sequence of movements in the production of basic shapes can be asked for the Chinese script, as in Chinese, the sequence of production is orthographically regulated. While sequential errors in the production process might not be visible in the final product the same way orthographic errors on the graphematic level are,[287] they have other repercussions. This foreshadows one of the more specific questions asked within the broader scope of *Natural Orthography* (Section 3.4): do orthographic regulations make natural practices (in this case a natural sequence in the handwritten production of basic shapes) less natural or, worse, more unnatural (which is not the same)?

Facilitation in handwriting leads to the emergence of informal variants of scripts. These are often called *cursive* in that they are "flowing, quick, and nonmonumental" (Treiman & Kessler 2014: 155). *Cursivization*, as a diachronic process, is a "well-known evolutionary [trend]" (Morin 2018: 674). Examples are the development of demotic script out of hieroglyphs (cf. Coulmas 1996a: 124) or the so-called "minusculization" of Roman script, i.e. the systematic development of lowercase basic shapes out of uppercase basic shapes due to an acceleration of production processes and a switch of writing surfaces from stone to papyrus and parchment (cf. Wiebelt 2003: 301). In this development, again, the *hasta-coda-principle* played a central role (cf. Mallon 1952; Brekle 1994a, 1994b, 1995, 1998). In the context of minusculization, it is not only the processes associated with producing lowercase basic shapes that are more natural (in that they are more economic, cf. Treiman & Kessler 2014: 180) than the processes involved in the production of uppercase basic shapes, but the product is also more natural in some respects. As Simpson et al. (2013) note, uppercase basic shapes exhibit less intra-inventory similarity than lowercase letters (i.e. their systematic fit is not as natural). Accordingly, in the literature, some scholars argue that lowercase basic shapes are the default while uppercase basic shapes are marked in their use (cf. Brekle 1998: 1; Primus 2004: 243, 2006: 9). Whereas in the case of minusculization, a whole new script inventory developed out of an initial script and consequently took on distinctive functions, sometimes, cursive variants coexist with more formal variants. In

[287] However, sometimes, sequential errors are visible. In the Chinese classes I took, when we were trying out calligraphy with brushes and ink, I could not hide that I had neglected to follow the correct stroke order. My teacher had not witnessed the actual production of the character I had attempted, but in the product, the nature of the brush strokes clearly revealed to her that I had produced them in a wrong sequence (and direction, on top of that; it was embarrassing). More drastically, Coulmas (1996a: 480) claims that "in the absence of a fixed order of strokes, handwriting would be impossible to read", as the sequence also assures that the product stays visually stable. The fact that calligraphy still plays an important role in China and Japan might be one of the reasons for the insistence on the correct stroke sequence in production.

Chinese, for example, among calligraphic styles, there are semi-cursive and cursive script styles in which the basic shapes appear drastically different from the shapes they take on in other, non-cursive variants of the script. Here, not only the elementary forms of the individual graphs are more connected than they usually are, but sometimes, the graphs themselves are also joined with one another (cf. Treiman & Kessler 2014: 155f.; Wang 1958; cf. Figure 37). Other examples for cursivization include ligatures that develop out of two units which are so intricately linked that they gradually become to be perceived as one unit: Latin *et* became the ampersand symbol |&| (cf. Tschichold 1981) and the German sequence of |ʃʒ| (or |ʃs|) merged and became the basic shape |ß| (cf. Häffner 2013). Ligaturing is also a very common feature in many scripts employed in abugidas (cf. Share & Daniels 2016: 25).

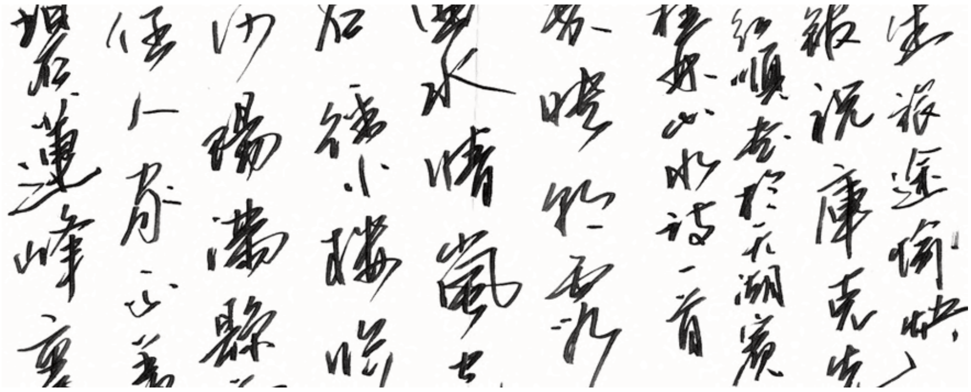

Figure 37: Chinese cursive script, from: https://blog.tutorming.com/hs-fs/hubfs/learn_chinese-copy-copy.jpg (February 9th, 2019)

A factor that interacts crucially with facilitation is frequency. Research suggests that basic shapes that occur more frequently in a writing system tend to be simpler and smaller than less common basic shapes; an example is that frequent basic shapes in Chinese have a smaller number of strokes than basic shapes that are used rarely (cf. Shu et al. 2003).

To sum up, for handwritten production, what is natural is a small number of curved, continuous segments that should best be connected. As for the orientation of basic shapes, if there is such a thing as a coda, it is most naturally located in the direction of writing.

Typing processes are entirely different from handwriting processes. Technically, typing can also be classified as "writing by hand" since it also involves the hands as articulators. However, nothing *per se* is graphically produced by the hands themselves when the fingers press the keys of a keyboard or typewriter.[288] Optimizing or facilitating typing processes, thus, cannot involve changing the shapes. As Treiman & Kessler (2014: 177) note, "typists can't get faster by modifying the shapes of letters, but they can press the keys more quickly". Thus, becoming faster in pressing the (correct) keys is an analog to facilitation in handwriting. Beginning typists are slower and work sequentially, as they have to locate the keys in succession. Usually, at this initial stage, locating the successive key involves looking at the keys (cf. Treiman & Kessler 2014: 177). Later, when a typer has built a "cognitive map of the keyboard" (Longcamp, Zerbato-Poudou & Velay 2005: 77), the location of keys can also be retrieved from memory. When it comes to the coordination of movements the hands have to make, the naturalness of involved processes varies: it is most natural when (1) the next key that needs to be pressed is pressed by the opposite hand, less natural when (2) a different finger from the same hand is used and least natural when (3) the same finger from the same hand is used. The varying degrees of naturalness of these three processes coincide with the time needed for executing them (cf. Treiman &

[288] Technically, nothing is produced by the hands either when writing with a pen, at it is the pen that produces the graphic traces; however, the mediation of the hands in the process is much more direct than it is in typing, as it is the actual movements that constitute the form of the product, which is not the case in typing.

Kessler 2014: 177; Gentner 1983; Terzuolo & Viviani 1980). Since writing instruments in general greatly influence production processes, and in typing, the distance between keys is crucial, the layout of keyboards is a central factor for the evaluation of naturalness in typing. The most widespread keyboard layout for Roman script is the QWERTY layout which was "designed in 1873 to minimize jamming of the keys by maximizing the distance between frequently typed pairs of keys". However, crucially, it was designed "without regard for ease of learning or typing" (cf. Rumelhart & Norman 1982: 2). Since individually, all key presses are the same, it is not easier to produce an |x| than it is to produce an |o|. Thus, natural processes with respect to typing can only be evaluated for sequences of key presses, and here, what is paramount, as mentioned, is the design of the instrument, the keyboard (cf. also Noyes 1983).

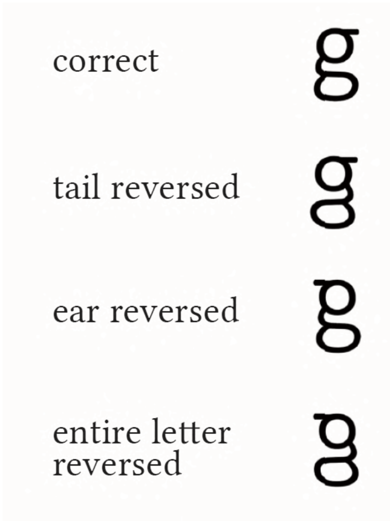

Figure 38: Correct |g| as well as distractors used in the experiment, from: Wong et al. (2018: 1330)

At first glance, it might appear inadequate or impossible to compare handwriting and typing processes since they are drastically different. However, in one respect, their naturalnesses can be compared: the effect they have on the memorization of shapes, in other words, the effect that the type of production has on cognition and, consequently, perception. This is a question that has also attracted the public's attention. Three findings are particularly worth mentioning here. The first involves a study by Wong et al. (2018). It focused on one of the inter-inventory free allographs of the grapheme <g> (cf. Section 2.2.1.2), so-called *looptail g* (also *closed-loop g*): |g| (as opposed to *opentail g* or *open-loop g*: |g|). Many of the participants in the study were not even aware that a second variant different from opentail |g| existed when asked if uppercase |G| has two lowercase equivalents. Indeed, open-loop |g| is common in a great number of fonts (predominantly sans-serif fonts) and, more importantly, in handwriting. Even after participants had to actively search for instances of the grapheme <g> in a text with multiple looptail gs, in a subsequent production task, most of them could only produce opentail gs and only one participant correctly produced a looptail g. Most strikingly, in a final experiment, when participants were presented with four possible choices of what looptail |g| could look like, of which one was correct and the other three served as distractors (cf. Figure 38), participants performed poorly in recognizing looptail g. What is striking about the findings of this study is that they suggest looptail g is, as ScienceDaily puts it, "a letter we've seen millions of times, yet can't write".[289] In fact, looptail g is more common in printed materials than opentail g (Wong et al. 2018: 1331). Yet, despite the "massive visual experience" (Wong et al. 2018: 1332), participants failed in the described tasks. One of the possible reasons, the authors suggest, is a lack of writing experience. Although the evidence is not definite, the findings point to the possibility that producing a basic shape contributes to *letter-shape awareness* (which I will call *basic shape awareness* in the following). The authors' model includes an *abstract amodal representation of a basic shape's identity* (which they formalize as {G}), *stored allograph representations* (in this case |g| and |g|) and a *graphic motor plan* (cf. Wong 2018: 1328). Producing an allograph, either |g| or |g|, helps strengthen the associated allograph representation, which, in the case of looptail g, since it is very rarely produced, fails to happen. A conclusion associated with this is that "letter-shape awareness does not always accompany the ability to recognize a letter shape via automatized reading processes" (Wong 2018: 1331). All of this implies that handwriting could be necessary or at least beneficial for stable representations of basic shapes and allographs, and that there is a "tight coupling between the visual and the sensorimotor perception of letter

[289] Cf. https://www.sciencedaily.com/releases/2018/04/180403140403.htm (January 29th, 2019).

shapes" (Longcamp, Zerbato-Poudou & Velay 2005: 68; cf. also Zemlock, Vinci-Booher & James 2018).

The second example I want to mention concerns a fairly modern phenomenon termed *character amnesia* (cf. Xu 2015). It occurs in users of the Chinese and Japanese writing systems who prefer to use modern, phonetic IME (Input Method Editors), systems that allow writers to input Chinese or Japanese graphemes by means of a phonetic Romanization. For example, when Mandarin users type "ma" in Roman script, they are presented Chinese graphemes with the phonological representation /ma/ and one of the tones, usually in order of frequency of use, and have to choose the one they intended to write. The widespread use of this input method has side effects, one of which is character amnesia,

> a state of affairs in which speakers of Chinese and Japanese, who are fully capable of *writing* (and obviously reading) almost any word they want by electronic means, often find themselves unable to *handwrite* correctly many of the same words if and when the need arises. In other words, they might experience this as a state of 'it's on the tip of my tongue' or, more accurately, 'on the tip of my pen'. (Almog 2018: 2)

As users of phonetic input systems who seldom handwrite never or very rarely use the graphomotoric programs for the basic shapes of Chinese and Japanese script, they forget them, in accordance with the provocative statement "use them or lose them". They are still able to recognize these basic shapes and the graphemes they embody, which is necessary in the use of phonetic input systems, but they can no longer write them by hand (similar, but not exactly equivalent to the situation with looptail g described above). Relying on alphabetic electronic input methods and a failure to (occasionally) produce the shapes by hand appears to lead to an impoverishment of graphomotoric programs. Only reading and typing, thus, could – and this is probably an exaggerated dystopian claim – gradually lead to forgetting how to write by hand entirely, making handwriting truly a "forgotten language skill" (Medwell & Wray 2008).

Two additional studies are noteworthy in the context of a comparison of handwriting vs. typing. In the first study, Longcamp, Zerbato-Poudou & Velay (2005) tested two groups of children aged 3-5 who either copied Roman basic shapes by hand (i.e. handwriting) or by typing in order to investigate whether movements involved in handwriting, as was suggested above, contribute to a stable mental representation of basic shapes that would serve recognition processes of these shapes. The results showed that in older children who had had more experience in handwriting, handwriting led to better results in subsequent basic shape recognition than typing. In the second study, Frangou et al. (2018) instructed Finnish students to transcribe dictated stories, using (1) a pencil, (2) a keyboard, and (3) a virtual touchscreen keyboard. 30 minutes after the task as well as one week later, the students' recollection for each writing task was evaluated, which led to the finding that handwriting resulted in a significantly better recollection both 30 minutes as well as one week after the initial dictation. This is seen as further evidence for the fact that handwriting has benefits for long-term memory. It is arguments such as these that are central in the public discourse on handwriting and the dreaded "demise" of handwriting. Handwriting is claimed to have more cognitive benefits than typing, and this is often one of the cited reasons that it needs to be "saved". However, this reduction of handwriting to its cognitive benefits is also criticized by some who argue that handwriting is also valuable in and of itself as a cultural technique.

To conclude this section on production, I want to briefly mention one of the most modern forms of writing: *swiping*. Touchscreens – on smartphones or tablets, for example – not only allow, but invite a so-called *direct touch* (cf. Ruf 2014: 51). Usually, there is no pen,[290] keyboard or other writing instrument between the finger and the writing surface, the screen (cf. Mangen 2016). The fingers directly touch and move on the screen, which has led to a gradual development of a grammar of so-called *touch gestures*, conventionalized movements with spe-

[290] There exist pens that can be used for touchscreens. However, in comparison with fingers, these pens are very rarely used.

cific functions. Actual *handwriting*, i.e. producing graphomotor programs on the screen, is, I would argue, although it is a possible input method, rather uncommon in the context of swiping. Text is rather entered through virtual keyboards displayed on the screen. However, swiping has introduced us to a whole new type of surface feel and requires fine motor skills. At the present time, research on swiping is scarce, but in the future, its effects on motor skills and other modes of production of writing must imperatively be included in a theory of writing (for a review, cf. Wollscheid, Sjaastad & Tømte 2016). Some studies suggest that the smoother surface of digital devices, which provides lower friction, can pose a challenge in the writing process (cf. Gerth et al. 2016a, 2016b). Furthermore, with respect to reception, screens as new surfaces should not be regarded as inherently less suited for reading than paper, which appears to be a strand of public discourse, as newer studies have suggested that when text display conditions are well matched between paper and screens (in the case of the cited study, tablet screens), there is no "reliable difference in reading between the two media" (Hermena et al. 2017: 1).

In general, this discussion highlights the importance of a paragraphetic perspective (cf. Section 2.2.1.2) and an investigation of writing materials. Materials and practices of inscription have recently become the subject of a collaborative research center entitled *Materiale Textkulturen* (transl. Material text cultures) which focuses on the materiality of writing in non-typographic societies. The eponymous series published by De Gruyter has spawned thirty books so far.[291] The inaugural volume (cf. Meier, Ott & Sauer 2015) includes sections on materials and practices, both complete with a multitude of chapters on, among others, stone, metal, paper, parchment, wood, papyrus, leather, wax, and practices such as drawing, chiseling, carving, weaving, etc.

3.2.2.3 Perception and cognition

Physiologically speaking, a visual stimulus first has to be *seen*. For that, it needs to impinge on the retina of the eye. It is then transferred to the primary visual cortex at the posterior pole of the brain's occipital lobe. What happens during this process has been described with the help of ERPs (*event-related potentials*). In my depiction here, I follow Rey et al. (2009). In the first 100-120 ms after a stimulus has been presented, cognitive activities at a lower level are at work. At this stage, people seeing a shape realize that something has entered their visual field. They analyze basal features of the visual stimulus, among them contrast, orientation, and connections of lines (cf. Brem & Maurer 2016: 124). It is also at this point that people recognize the presented stimulus as a special type of stimulus, e.g. a basic shape of Roman script. Further visual processing takes place in neighboring brain areas, predominantly in the ventral part of the occipital and temporal lobes, and here, specifically in the so-called *Visual Word Form Area* (VWFA, cf. Dehaene 2009) which is part of the fusiform gyrus (in Brodmann area 37). Between 120-180 ms after the initial presentation of a stimulus, higher cognitive processes become involved. This cognitive activity is explained through the process of the recognition of basic shape ('letter') features. At this point of processing, basic shapes from scripts that exhibit case distinction are still specified for case, i.e. as lower- or uppercase basic shapes. It is only after 220 ms that an abstract and case-invariant representation – a grapheme – is activated. From 300 ms on, the person who was presented a grapheme is capable of reacting to the stimulus: they have perceived the letter consciously and can follow instructions that require successful prior recognition.

This sketch of the grapheme recognition process allows the rough separation of temporal stages at which lower cognitive activities are at work from those at which higher cognitive activities are central. The former are led bottom-up by the visual stimulus, while the latter are controlled top-down by knowledge. Some models (see below) assume these two processes occur simultaneously and not in sequence. With respect to this distinction, some interesting ques-

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[291] Cf. https://www.degruyter.com/view/serial/428997 (February 1st, 2019).

tions can be studied, among them: at which point does the concrete visual appearance of a stimulus – and this includes specific styles of handwriting or typefaces – play a role? In their study, Keage et al. (2014) showed that it is indeed the first 300 ms in which visual characteristics are crucial. This was tested in an experiment in which participants were presented with different typefaces which had been, based on their visual appearance, categorized as *fluent*, i.e. easy to read, such as Times New Roman or Arial, and *disfluent*, i.e. harder to read, such as Lucida Blackletter. Their results suggested that "the initial abstraction of letter meaning is more difficult when the letter is presented in a disfluent typeface, and further, that such a presentation captures more attention than material written in fluent typeface" (Keage et al. 2014: 87). In this section, I will not focus on how features of concrete stimuli – actually materialized graphs – affect processing, but which features of abstract basic shapes are of relevance. Based on the descriptive grapholinguistic model established in Chapter 2, a central question is: when, in the course of visual processing, is a stimulus a *graph*, when does it become a *basic shape*, and when is it finally categorized as a *grapheme*? This question, of course, subsumes the question of when perceiving becomes understanding, physiology becomes cognition, and graphetics becomes graphematics.

A study broaching this question comes from Friedman (1980). In her experiment, participants were presented, among other things, with uppercase and lowercase letters of Roman script (in my terminology, basic shapes). After letters had been presented, participants were asked whether they had seen an uppercase or lowercase letter. Even in cases in which prior to the presentation, participants had specifically been instructed to remember and, later, recall and state the case in which a letter had been presented, most of their answers were incorrect, i.e. they could not recall the case in which a letter had been presented. Interestingly, although Friedman and authors of similar studies speak of an "abstract letter representation", what these findings suggest instead is either that a grapheme with different allographs has been recognized or that there exists, independently of their assignment to the same grapheme (for whose recognition linguistic information must have been processed), a category that subsumes shapes such as |a| and |A| although they differ visually. In general, it is assumed that in the recognition process, graphs are, in the first step, abstracted to basic shapes, and, in the next step, to graphemes, which, in psycholinguistic terms, have been called *abstract letter identities* (ALIs, cf. Coltheart 1981: 247; Günther 1988: 156) or *abstract letter units* (ALUs, cf. Finkbeiner & Coltheart 2009: 4). Sometimes, an additional level of *case-specific letter units* (CSUs, Finkbeiner & Coltheart 2009: 5) is posited which is located between the concrete visual stimulus (= graphs) and ALUs (= graphemes) and corresponds to the descriptive category of basic shapes. Terminologically, CSU is a bit too narrow as the same kind of phenomenon can be observed for other pairs of basic shapes such as |a| and |ɑ| or |g| and |g| that are not distinguished by case (cf. Meletis 2015: 162). In scripts other than Roman, too, there exist analogous distinctions that are not due to case, such as positional allographs in Arabic. They, too, are abstracted at some point in the recognition process and treated as one abstract unit (cf. Carreiras et al. 2013). In sum, it is important to note that the assumption of the descriptive categories of the *graph* and the *basic shape* (for the graphetic level) and the *grapheme* (for the graphematic level) are supported by external evidence from processing.

To this day, the *Interactive Activation Model* (IA Model) established by McClelland & Rumelhart (1981) remains one of the most influential models of the perception of writing. It includes the three levels of (1) letter features, (2) letters, and (3) words. The assumption of these levels can explain many of the effects observed in the recognition and reading process, such as the *word superiority effect* first observed by Cattell (1885) (cf. also Reicher 1969). Recognition of units works not only bottom-up, through the identification of features which activate the letters they are a part of, but also top-down, when the recognition of a number of letters allows the identification of the whole word and this, in turn, allows the top-down recognition of the remaining, yet unidentified letters. This bilateral functioning of the model is its greatest strength. One of its weaknesses is that it cannot explain effects of letter transposition, i.e. when words are recognized although their letters are 'jumbled'. This weakness has prompted the development of newer models which can deal with positional flexibility of basic shapes and graphemes (cf. Section 3.3.2.7). Other influential models that strive to explain the reading process include so-called dual-route models such as the *Dual-Route-Cascaded Model* by Coltheart et al. (2001). These models rest on the assumption that there exist two possible routes for word recognition: a visual route leading directly to the lexicon and a phonological route that takes a 'detour' through the phonological representation of a word and only then leads to the lexicon. One of the drawbacks of these models, which echoes the situation in grapholinguistics in general, is that they are suited to explain recognition processes in English but not in structurally different languages (cf. Christmann 2016: 27; for a general criticism of "alphabetism" in reading science, cf. Share 2008, 2014). Another influential model is the connectionist triangle model (Seidenberg & McClelland 1989). Together with similar models, it is subsumed under the group label *Parallel Distributed Models* (PDP models). These models are considered triangular as they assume that orthographic, phonological, and semantic information is processed, and they are parallel in that they assume these types of information are processed in parallel. In the following, models of basic shape, grapheme, and word recognition will not take center stage, but they will be referred to at certain points and should be kept in mind, especially with respect to the question of how well they account for the graphetic features relevant in processing.

One of the most important, though at first glance vague determinants of perceptual graphetic naturalness is certainly visual complexity. Complexity is interpreted here in the absolute sense (cf. Section 1.5.3), i.e. as the descriptive complexity of written shapes that is independent of its processing by humans. By itself, the term *visual complexity* is ambiguous. Accordingly, in the literature, it has been used in a multitude of ways. In an elaborate study, Chang, Chen & Perfetti (2018) offer a useful subdistinction of factors that contribute to the overall visual complexity of individual basic shapes and, in turn, whole scripts. The multidimensional measure for visual complexity that they call *GraphCom* takes into account four aspects: first, so-called (1) *perimetric complexity*, which I have called *density* or *grey-scale value* in the proposal of descriptive categories for a script typology (cf. Section 2.3.1). It captures "the density of the written marks ('black ink') relative to the background space in which they are located" (Chang, Chen & Perfetti 2018: 429). In the descriptive graphetic framework presented in Section 2.2.1.2, the space relevant for the evaluation of perimetric complexity is the segmental space. As a submeasure of complexity, perimetric complexity is quantitative and size-invariant, meaning it is not affected by the size of basic shapes (or, at the concrete level of graphs, font size). As Pelli et al. (2006) showed in their study, perimetric complexity is inversely proportional to the efficiency with which basic shapes are identified. Thus, the greater the perimetric complexity of a shape, the greater is also the cost for processing. However, perimetric complexity alone is certainly not a sufficient measure of general visual complexity as it fails to capture internal structural aspects. Theoretically, two basic shapes could share the same perimetric complexity but differ drastically in their structural makeup (cf. Chang, Chen & Perfetti 2018: 430; see below). Here, the remaining three factors of GraphCom come into play. They are highly influenced by *gestalt theory*, especially the principles of proximity, symmetry, convexity, closure, connectedness, and continuation. Accordingly, the (2) *number of disconnected components* is a second factor contributing to GraphCom. For example, the basic shape |Ξ| of Greek script consists of three unconnected components. Unconnectedness was already mentioned above as being unnatural in handwriting precisely due to the disconnected nature of its components which requires lifting the writing instrument. This lack of connection between elementary forms introduces a visual empty space (discussed at length in Section 2.2.1.2) at the subsegmental level. The third factor of visual complexity is the (3) *number of connections*. In |A|, for example, there are three connections. As will be elaborated below, these connections have been found to be relevant in the recognition of basic shapes (cf. Lanthier et al. 2009). The fourth and last factor included in GraphCom is the (4) *number of components*, i.e. elementary forms.[292]

[292] Note that Chang, Chen & Perfetti (2018: 449) call these components "simple features (SF)": "SF is a discrete element that can be discriminated from others […]. Other examples for one simple feature in-

The study analyzed 133 scripts (and *not* 133 "written languages", cf. Chang, Chen & Perfetti 2018: 431). It only considered the form of isolated basic shapes and not the form of sequences of connected basic shapes (cf. Chang, Chen & Perfetti 2018: 432). Also, the visual complexity values for different scripts are correlated with the types of writing systems (alphabets, abugidas, etc.) that these scripts are used for. The nature of this correlation is nowhere explained and the basis for such a groundbreaking assumption of a fundamental form-function-correlation remains implicit, which is a severe flaw of the study.

Despite its drawbacks, a number of the study's findings are striking. Firstly, the number of unconnected elementary forms appears to be the most relevant distinguisher between scripts. Secondly, a behavioral experiment confirmed the hypothesis that two basic shapes that are similar in GraphCom will also be judged as similar by observers and that each of the four dimensions of complexity affected processing. In a different experiment of the study, complexity was correlated with training times needed in a computer simulation of graph learning (cf. Chang, Plaut & Perfetti 2016). Thirdly, "graphic complexity is largely driven by the number of graphs [= basic shapes, D.M.] that is needed in a written language [= script, D.M.]" (Chang, Chen & Perfetti 2018: 438). This means that with regard to scripts, the number of basic shapes and their complexity interact in crucial ways. This insinuates that basic shapes of a large script such as Chinese will exhibit, in sum, a higher visual complexity than the basic shapes of a much smaller script such as Roman (cf. Section 3.2.1). Other studies have corroborated the influence of a script's visual complexity on processing: studies by Shimron & Navon (1981) for Hebrew, Eviatar & Ibrahim (2004) for Arabic, and Nag et al. (2014) for Kannada have shown that visual complexity affects reading times and knowledge of basic shapes among skilled and beginning readers.

The visual complexity discussed so far is of quantitative nature. It evaluates the quantity of information in general and different subtypes of information such as elementary forms and connections. There is, however, also a qualitative, structural dimension to visual complexity (cf. Chipman 1977; Chipman & Mendelson 1979). Even if two basic shapes share the same perimetric complexity, number of elementary forms, and (dis)connections, they can still be visually distinct, since quantitative complexity reveals nothing about the structural makeup of visual information within the segmental space. Thus, *quantitative visual complexity* and *qualitative visual complexity* need to be separated. They interact in crucial ways, however, as qualitative complexity can reduce the perception of quantitative complexity. It is "a structural variable representing organization, symmetry, and other similarity transformations present in the patterns, which reduces perceived complexity" (Gartus & Leder 2017: 19). In the following, I will first discuss how the force of homogenization affects perceptually relevant features before the focus will shift onto the specific graphetic features that have been found to affect perceptual processing and might together contribute to the qualitative complexity of basic shapes. Many of them are well-known as preattentive features relevant in vision (cf. Wolfe 2000: 344-354) and also as principles of gestalt theory. They include relational features such as *similarity*, *distinctiveness*, *redundancy*, and *variation* as well as individual features such as *symmetry*, *cardinality*, *directionality*, *(dis)connectedness*, *types of connections*, and *location of connections*, i.e. *topology*, and *curvedness*. This list and the ensuing discussion are not exhaustive, but they outline the most central phenomena for an evaluation of a graphetic processing fit.

At the beginning of the present discussion of the processing fit, Watt's (1983b) four forces of script change were introduced. The force that was said to affect perception the most is *homogenization*. Although the homogenization of basic shapes in a script is made possible by

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clude a line, a dot, a circle, or a curved line". As discussed in Section 3.2.1, following Watt (1975), the term "feature" is not fitting for these components. These components are elementary forms, and they are themselves made up of abstract features such as [±long] or [±round]. Meshing these two levels together adds redundancy to the level of components since various components have to be assumed in cases in which two components share the same shape but differ only in one feature on a lower level, i.e. orientation, such as |c| and |ɔ|.

perception, as shapes which are homogenized first need to be visually perceived, it is fundamentally driven by cognition, more specifically the human brain's tendency to form systems out of groups of elements by rendering these elements more systematic. This preference for systematicity leads to a convergence of the elements in an inventory. Although it is ultimately enabled by perception, homogenization is not entirely beneficial for perception. Quite to the contrary, it has a flip side: introducing visual ambiguity. In the history of scripts, homogenization, together with production-driven facilitation, has sometimes resulted in situations in which basic shapes became virtually identical in their visual makeup. An example in which a *homograph clash* (Brekle 1998: 8) was successfully avoided is the development of a minuscule variant of |G|. Because of an imminent visual clash with existing |q|, the lowercase equivalent of |G| evolved a left-leaning curved coda in the lower subspace of the segmental space, i.e. in its descender: |ɡ|. This coda is not located in the central subspace of the segmental space, where codas of lowercase basic shapes are usually positioned, which marks |ɡ| as an exception in the inventory of Roman lowercase basic shapes. This exceptionality is the result of the need to avoid visual ambiguity with |q| (cf. Brekle 1998: 8). Other prominent examples of changes that led to the collapse of once visually distinctive shapes are the basic shapes |ت|, |ب|, and |ث| in Arabic. Their visual convergence was motivated by productional facilitation, which highlights the conflict between productional economy and visual ambiguity. As Salomon (2012: 122) puts it, "excessive simplification carries with it the danger of reducing the visual distinctiveness of a character to the point that it cannot be distinguished readily [...] from other similarly reduced characters". The homogenization of these basic shapes in Arabic invoked the counter-force of heterogenization which led to the secondary introduction of (albeit visually non-salient) dots in order to distinguish them again (cf. Gruendler 2012: 97f.). Thus, homogenization and heterogenization often go hand in hand in what amounts to a "cyclical process" (Salomon 2012: 123).

As the examples show, homogenization and heterogenization are responsible for two opposing relational principles that affect processing in fundamental ways: *similarity* and *distinctiveness*. The perceptual apparatus tends to favor a certain degree of similarity, which is a necessary byproduct of high levels of systematicity in a script. However, before homogenization overdoes it, heterogenization has to step in to stop the development or even undo effects of prior visual assimilation. The question of how similar a script's basic shapes are can be answered by means of the relation of the number of basic shapes and the number of features. Tendentially, if the number of features is greater than the number of basic shapes, there is room for efficient distinctiveness, whereas if the number of features equals or is lower than the number of basic shapes, some basic shapes are on the verge of visually collapsing or have already merged. This ratio alone is not a reliable indicator of similarity, however. A second crucial factor is the qualitative nature of the features themselves. In the Arabic basic shapes listed above, for example, the distinguishing features (dots) are not as salient as the modified basic shape itself. Graphetic distance, thus, can not be assessed solely by counting in how many features two shapes differ but must include a consideration of the nature of these features. |O| and |Q| differ in one feature, as do |P| and |R|, but one could argue the former pair is more similar than the latter. Although no scripts have yet been elaborately described in terms of a featural analysis outlined in Section 3.2.1, it often seems "visible" at first "glance" that the basic shapes of some scripts are more similar than others. As an example, Figure 39 shows a number of easily confusable pairs of basic shapes from Thai script (cf. Winskel 2010 for an analysis of similar basic shapes). Other scripts that show a high degree of similarity among their shapes are Hebrew, the lowercase inventory of Cyrillic, and Armenian (cf. Daniels & Share 2018: 106).

ฉ→อ	ฃ→ข	ฑ→ท	ฅ→ค	ฅ→ด	ผ→ม,น	ย→บ
ช→ข	ศ→ค	ส→ล	ฮ→ส,อ	ถ→ด,ก	ซ→ช	ฃ→ฃ
ฎ↔ฏ	ฬ→พ,ห	อ→ล	ร→ว	ท→ห	ธ→ร,อ	บ→ม
จ→ฯ,อ,ฉ	แ→น	ๆ→า	ฯ→ๆ	ไ→ใ←โ	๊↔็↔๊	ั↔็

Figure 39: Easily confusable pairs or groups of basic shapes in Thai script, from: Punsongserm, Sunaga & Ihara (2017: 17)

Before visual homograph clashes such as the ones mentioned above occur, the force of homogenization merely leads to an increase in systematicity and, thus, to an improvement of the systematic fit of a script (cf. Section 3.2.1). A central process operating for the force of homogenization is overgeneralization. It can be interpreted as a perceptual natural graphetic process. During processing, overgeneralization can lead to instances of misremembering. Arguably the most famous example for this is the outlier |J| in the uppercase basic shapes of Roman script. If, during production, one feature – e.g. the sole feature that does not conform to the features of the overall script, [−right-oriented] – is forgotten, writers – in this case predominantly children – replace it with the feature that is statistically dominant or more natural in the script (for a difference between the two, cf. Section 3.2.2.1). In this case, children often produce an inverted version |Ⴑ| which is not an existing basic shape of Roman script (but, in fact, one of the licensed gaps, cf. Section 3.2.1). As this example proves, it is not only productional natural graphetic processes that lead to homogenization, but in many cases also perceptual ones, even if these show themselves only in production.

With respect to perception, a completely natural systematic fit of a script, which equals a complete lack of redundancy, can be a disadvantage for processing. In this context, extrinsic symmetry is a feature of scripts that is unnatural. It is the reason why children have difficulty distinguishing |b| and |d|. They are also challenged by, albeit to a lesser degree, horizontal symmetry such as in |M| and |W| (cf. Treiman, Kessler & Pollo 2006: 224) or |u| and |n|.

In the case of extrinsic symmetry, a number of aspects converge to make processing harder. Even though children realize early on that writing is a two-dimensional artifact (see above), one of the central cognitive skills they employ when recognizing three-dimensional objects cannot easily be deactivated in the perception of writing: *object constancy*. This cognitive skill "makes it possible to perceive an object regardless of its orientation in space" (Wiebelt 2004b: 276). Accordingly, it is difficult for children to accept |b| and |d| as distinctive units because they represent the same basic shape and differ only in orientation (for a discussion of orientation, cf. also Willows & Geva 1995: 363-365). Extrinsic symmetry, thus, contributes to the similarity of the shapes within a script. With the exception of a number of typefaces in which differences between |b| and |d| are – even if only minimally – emphasized to increase distinctiveness and legibility (cf. Wiebelt 2003: 303f.), these shapes are, in print, always inverted. This requires children to grasp that the same shape can have different meanings, even if usually, they recognize, for example, a chair whether they see it from above, below, or any horizontal angle. Thus, extrinsic symmetry (unlike intrinsic symmetry, which poses no such problems) constitutes a cognitive hurdle that "must [...] be overcome during reading acquisition" (Pegado et al. 2011: 742). The evidence strongly suggests extrinsic symmetry is unnatural, as it poses not only problems for children in writing and reading acquisition, but also for people suffering from disorders of reading and writing (cf. Willows & Terepocki 1993).

Additional strong evidence for the unnaturalness of extrinsic symmetry comes in the form of its diachronic decrease in the scripts of the world (cf. Wiebelt 2003, 2004a, 2004b). At the relative beginnings of the history of writing, intrinsic symmetry was the only kind of symmetry prevalent in scripts, and this is based on the pictographic nature of ancient writing systems, i.e. the fact that the symmetry perceived in nature and the surroundings of scribes were pictographically manifested in the shapes of writing. In cases in which extrinsic symmetry did occur in these early stages, extrinsically symmetrical shapes had opposing graphematic values (such as *come* vs. *return*). A demonstrative instance of the introduction of extrinsic symmetry to a script came with the minusculization of the uppercase basic shapes of Roman script (see above). As implied above, complete symmetry was avoided by introducing secondary visual features such as serifs. While the origin of serifs might have been due to productional or aesthetic reasons, their preservation over such a long period of time is arguably due to the beneficial effect they have on perception (cf. Wiebelt 2003: 303f.). Even after the introduction of such features that made extrinsically symmetrical shapes more distinctive, these shapes represented a challenge for perception. This fact, in the vein of the theory of *natural change*, justifies the question of why extrinsic symmetry was not eliminated altogether. One of the reasons, Wiebelt (2003: 306) argues, is to be found in the principle of conservatism. Indeed, eliminating or switching out basic shapes that have been integral parts of a script over a long period of time is certainly an invasive procedure.

Wiebelt not only investigated extrinsic symmetry in "scripts which have been used for a long time by a large community" (Wiebelt 2004b: 277), which she terms *mature scripts*, but also "scripts which serve special purposes" (Wiebelt 2004b: 277) such as scripts invented for a specific (fictional) work of literature, secret scripts, or scripts intended for a special function, which she classifies as *invented scripts*. It is striking that invented scripts exhibit a significantly higher degree of extrinsic symmetry in comparison with mature scripts. The explanation for this consists of several factors. Firstly, extrinsic symmetry, similar to pictography (cf. Section 3.3.2.2), benefits not only writers who use an existing script, but also the initial creators of a script, as the practice of creating new shapes by inverting existing shapes arguably requires less effort than coming up with entirely new shapes. Thus, inverting shapes appears to be a productive way of generating new shapes in the context of script creation. Secondly, the factors of use and time play crucial roles (cf. Section 1.1.2). Even if extrinsic symmetry develops at some point due to productional reasons, it is drastically reduced and sometimes even eliminated in mature scripts since they are extensively used over a long period of time – they are, in Keller's (2014) conception, *phenomena of the third kind* affected by invisible-hand change. Invented scripts, on the other hand, are not affected by use and time in the same way. Wiebelt (2003: 321) estimates that with respect to (the lack of) extrinsic symmetry, scripts are perceptually natural if their development spans at least 500 years. As a practical consequence of these results, Wiebelt (2004b: 300) cautions that "the creation of a new widespread script should avoid extrinsically symmetrical signs at all costs", which is crucial in the rare cases in which such a creation is wished for or necessary.

In sum, all types of external evidence central in Naturalness Theory (cf. Section 1.3.3) converge with respect to the feature of extrinsic symmetry, making it a perfect proposal for a(n) (un)naturalness parameter of writing that constrains the structural makeup of scripts.

Intrinsic symmetry is an entirely different story (for a review, cf. Giannouli 2013). Since intrinsic symmetry is an individual feature, i.e. concerns only individual basic shapes and not their relation with other basic shapes in an inventory, it does not pose a cognitive challenge. With respect to the anisotropic subtypes of intrinsic symmetry, Morin (2018: 665) claims that vertical symmetry (as in |M|) is more natural than horizontal symmetry (as in |B|) as "[o]ur brains are attuned to vertical (as opposed to horizontal) symmetry". This corresponds with the fact that vertical symmetry is also the most common type of symmetry found in nature (cf. Wiebelt 2003: 299) and that sensitivity to vertical symmetry is acquired earlier than sensitivity to horizontal symmetry (cf. Chipman & Mendelson 1979: 375). It is also noteworthy that there is evidence that intrinsic symmetry reduces the perception of quantitative visual complexity (cf. Gartus & Leder 2017), marking it a natural feature of writing in stark contrast to unnatural extrinsic symmetry.

Extrinsic symmetry was introduced above in the context of redundancy in scripts. To elaborate this further, consider the extreme example of Cree script (cf. Figure 29 for a selection of Cree basic shapes). In Cree, a number of the principles sketched above are executed to the fullest possible degree: the script has the most natural systematic fit with regard to the orientation of basic shapes, as there are no outliers similar to |J| in Roman script. In other words, features of orientation – leftwards, rightwards, upwards, downwards – are almost perfectly spread throughout the script. Thus, the same shape is consistently used in different orientations – and not just two of them as in |b| and |d|, but all four as in |ᐸ|, |ᐯ|, |ᐱ|, and |ᐳ|. Each shape, depending on its orientation, is employed for a different grapheme that needs to be distinguished from the other graphemes for the reading process to be successful. While the orientation-invariant shape consistently represents a consonant phoneme – all the four shapes in the above examples represent /p/ –, the shape's orientation indicates the vowel phoneme that is represented. Additionally, the same orientation always indicates the same vowel, independently of shape, so the right-oriented shapes |ᐸ|, |ᑕ|, and |ᒐ|, for example, all indicate the vowel /a/. Thus, both shapes and orientations are diagrammatical, which is, from a semiotic point of view, highly natural (cf. Section 3.3.1.2). However, due to the above-mentioned cognitive skill of object constancy, the status of orientation as a graphematically distinctive feature hinders processing. As Treiman & Kessler (2014: 166) note, if a child acquiring literacy in Cree were to misremember a certain grapheme's feature value on the feature of orientation when writing or reading, filling it in with the wrong value will in (almost) all cases result in the production or perception of a wrong shape and, automatically, and more devastatingly, a wrong grapheme. This is a result of the lack of redundancy with respect to the feature of orientation. There are no systematic gaps regarding the feature of orientation, as every basic shape that is imaginable is actually an existing unit of the script. If there were, by contrast, a certain degree of redundancy, misremembering a feature of a given basic shape would also result in the production of an erroneous basic shape, but this erroneous shape might not be a member of the script but instead a systematic gap that is not associated with any grapheme (such as |ᒐ| in Roman script).

Redundancy, as a relational principle, is not only affected by potentially distinctive features such as orientation, but also by non-distinctive features. Visual variation at the concrete level of graphs, i.e. the concrete materialization of scripts, also represents a form of redundancy. From a sociocultural perspective, expressiveness is a resource of writing (cf. Section 3.2.3) as it allows people to express facets of their personality or the specific writing situation and to socially position themselves with the help of graphetic means. At the same time, however, from the perspective of processing, visual variation represents a challenge to beginning readers who have to learn to distinguish distinctive, i.e. graphematically relevant features from decorative non-distinctive features (cf. Treiman & Kessler 2014: 161f.). The stages of this process are reflected by the initial over-emphasis of distinctive features in literacy acquisition, e.g. when the dots in Arabic basic shapes are produced much bigger than usually in relation to the rest of the basic shape (cf. Kenner 2004: 83f.; cf. Figure 40). The cognitive hurdles of visual variation are soon overcome, however, unlike the problems posed by the similarity of distinctive basic shapes of a script (see above). Interesting evidence on the effects of visual variation comes from the relationship between handwritten production and perception: studies suggest that the acquisition of scripts with higher visual complexity strengthen visual skills (cf. Chang, Chen & Perfetti 2018: 429; Kenner 2004: 76). In particular, the fact that in handwriting, children produce variable graphs, i.e. their written output is visually variable, appears to benefit the perceptual system as it is offered more perceptually variable instances for one category, i.e. more graphs for one basic shape (cf. Li & James 2016). The graphs that are produced, however, are also dependent on mental abstract representations of shapes which have been established on the basis of prior perception. Perception and production, thus, again interact in crucial ways, with perception being the more dominant of the two as it is always simultaneously a part of production.

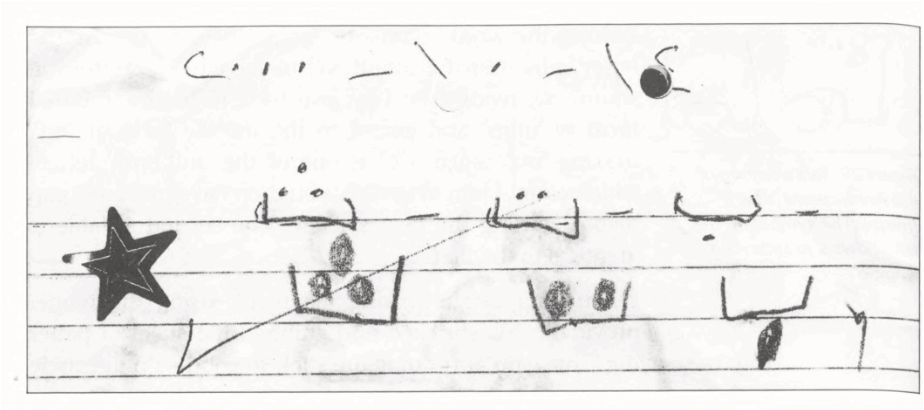

Figure 40: Overemphasis on dots in Arabic, from: Kenner (2004: 84)

Redundancy can be interpreted not only as a relational feature of an entire script but also as an individual feature of single basic shapes. In correspondence with this, the results of Changizi & Shimojo's (2005) study suggest that in a large number of the world's scripts, half of the features of basic shapes usually suffice for their recognition. However, features, or, in general, visual informational load, is not distributed evenly in a script's basic shapes. This was shown by Kolers (1983: 373), who observes that "not all parts of a letter contribute equally to its identity" and speaks of a *polarization* of information. Cutting away either the right halves or the left halves of Roman uppercase and lowercase basic shapes reveals that more relevant information for the recognition of shapes appears to be polarized in the right half. This, Kolers (1983: 376) hypothesizes, might be due to eye movements, particularly the direction in which they move: the reading direction in writing systems using Roman script is dextrograde, so the eyes move rightwards, which is where the bulk of the relevant visual information is positioned. For Hebrew shapes, employed in a sinistrograde writing system, Kolers's informal analysis reveals that information is polarized on the left, and in Chinese shapes, the bottom half as well as the left side appear to be more informative (cf. Chou 1930), which coincides with the traditional sinistrograde downward reading direction. This sort of *directional polarization*, of course, could simply be a reflection of the parameter of writing-direction-orientation outlined above, which favors codas and appendices in basic shapes that are located in the writing direction.

Another relevant parameter of graphetic processing naturalness is *cardinality* of elementary forms (as in |I|) vs. *obliqueness* of elementary forms (as in |/|) within basic shapes. This feature was the focus of a study by Morin (2018) who hypothesizes that "cardinal (vertical and horizontal) orientations, being easier to process, should be overrepresented in letters" (Morin 2018: 664). Easier to process means easier to recognize, discriminate, and memorize (cf. Morin 2018: 665). Morin's analysis of 116 scripts shows that cardinal segments are not only overrepresented in visual systems but tend to not mix with oblique strokes: mixed basic shapes such as |K| remain exceptions. Roman script, in fact, exhibits a separation effect in that basic shapes are either composed of purely cardinal segments such as |E| or purely oblique segments such as |W|. Mixed shapes such as |K| and purely oblique shapes like |W| are less natural insofar as they include acute angles which, for example, are less faithfully copied by children than right angles as in |T| (cf. Davis, De Bruyn & Boyles 2005). Fiset et al. (2009) confirm that, in addition to line terminations (see below), vertical strokes appear to be the most important feature in the recognition of uppercase Roman basic shapes.

The number of elementary forms as well as their connections and disconnections in a basic shape were mentioned as relevant factors of quantitative visual complexity, but the exact nature of elementary forms is a matter of qualitative visual complexity. Changizi et al.'s (2006) already mentioned study showed that several visual topological configurations that are prevalent in nature are reproduced in the structural makeup of basic shapes. Topology is a relevant variable in visual processing (cf. Wolfe 2000: 353f.), as there is ample evidence that in perception, global topological configurations are used to distinguish between shapes (cf. Kanbe 2013).

Topology, as I interpret it here, concerns not only the connections between elementary forms but also their position in the segmental space and their position relative to one another. With respect to connections, Lanthier et al. (2009) showed that the removal of internal parts of strokes is less detrimental to processing than the removal of connections, i.e. apices and vertices (cf. Figure 41). This highlights the relevance of topological information in the form of connections. The visual complexity of different types of connections has been quantified in theory, with continuous contacts as in |O| or |~| assumed to be the least complex, followed by crisp contacts as in |T| or |F|. Crossings such as in |X| or |+| are claimed to be the most complex connections (cf. Altmann 2004: 69f.). However, research on the different effects of these connections on processing is scarce. Line terminations have also been found to play a crucial role in visual processing: the lower line termination in |C|, for example, makes possible the distinction from |G| and |O| (cf. Fiset et al. 2008: 1166f.). |C| and |O| differ also in closedness, which, in addition to connectedness, has been described as an important feature for visual processing and corresponds to the *gestalt* theoretical principle of closedness (cf. Chen 1982: 699).

Figure 41: Deletion of midsegments and terminations, from: Lanthier et al. (2006: 68)

For connectedness as a relational rather than an individual feature, it is revealing to consult studies on connected scripts such as Arabic as well as to compare unconnected print with cursive connected handwriting in scripts such as Roman. Connectedness was identified as a natural feature in production, but is the same true for perception, or is the lack of visual segmentality detrimental to the perception of individual shapes? For writing systems using Roman script, which appears unconnected in the vast majority of typefaces, evidence points to the latter. In a study involving French adults and children, both groups recognized cursive words with connected graphs less efficiently than printed words with unconnected graphs (cf. Danna et al. 2018). This was also confirmed for Spanish, where "a small, but significant advantage in response times for those words composed of separated letters than for those composed of connected letters" could be observed (Roldán, Marcet & Perea 2018: 285). In Arabic, the opposite seems to be the case: several studies found that connected words are more easily processed than words in which graphs are unconnected, i.e. connectedness benefits the reading process (cf. Taha, Ibrahim & Khateb 2013; Khateb et al. 2013). These diverging results are interesting with respect to the interaction between the subtheories of naturalness: it is possible that either connectedness or segmentality are universally natural features, but as readers of Roman script are more familiar with unconnected writing and readers of Arabic script are more familiar with connected writing, these respective features are natural for them at the system-specific level, overriding the universally natural feature (cf. Khateb et al. 2013: 226f.). While this does not settle the question of whether segmentality or connectedness are universally more natural, segmentality must be more natural at some level: in Arabic, too, there are empty spaces between words. These guide eye movements and the reading process even in the absence of spaces between segmental units (cf. Section 3.3.2.8). A writing system entirely lacking segmentality would, probably, even if connectedness is natural system-specifically, be harder to process than a writing system exhibiting segmentality at the grapheme or word level.

A final perceptual feature I want to mention is curvature, also referred to as roundness, the opposite of angularity. It is a salient feature, as not only basic shapes within a given script differ with respect to it, such as |H| and |C| in Roman script, but also entire scripts, such as the curved Georgian and Burmese scripts vs. the angular Hangul or Hebrew scripts. There exists no research on the question of whether round or angular basic shapes are more natural perceptually, although some evidence points to a preference for curves. For example, there is strong evidence that curves are aesthetically preferred (cf. Cotter et al. 2017; Bar & Neta 2006; Silvia & Barona 2009). This could be proven for typefaces when they were adjusted to be more rounded or angular (cf. Kastl & Child 1968). In a similar vein, Velasco et al. (2015: 1) instructed participants to match round or angular typefaces with taste words and found that round typefaces were associated with attributes such as “sweet” while angular typefaces were associated with “bitter”, “salty”, and “sour”. The authors hypothesize that this could be caused by the fact that round typefaces are easier to process. The causal relationship might also be inverse, however: aesthetic preferences and attitudes towards typefaces might affect ease of processing. Actual evidence on the effect of these features on processing is almost non-existent, and only some bits can be found scattered in the literature. For example, one study which focused on visual processing in dyslexics used basic shapes from Georgian script, which are predominantly round, and found that dyslexics performed as well as normal readers. The specific visual appearance of the shapes was not specifically tested – instead, factors such as letter size, letter crowding, the addition of white noise, etc. were analyzed –, but the results of the study indicate at the very least that roundness might not be detrimental to reading (cf. Shovman & Ahissar 2006). In fact, there might not be a preference for roundness vs. angularity in perception at all. As studies show, both curves and round shapes as well as straight lines and angular shapes are relevant features in the perception and recognition of basic shapes (cf. Chang, Furber & Welbourne 2012: 2786; Fiset et al. 2008, 2009). Undoubtedly, roundness vs. angularity is one of the (many) features for which more data is needed in order to reasonably include it in a theory of writing.

3.2.3 Sociocultural fit

Writing is a cultural technique, which is why sociocultural considerations must always occupy a central role in grapholinguistics. Since it is directly perceivable with our visual sense, the material appearance of writing is particularly important to its users. In their semiotic approach, Klinkenberg & Polis’s (2018: 82) note that the appearance of writing “is frequently associated with a producer or a group of producers [and] yields a signature effect”. Accordingly, it can have symbolic, indexical, or iconic functions. This is true for the appearance of an individual’s handwriting, but also for someone’s choice of typeface in a given context. More globally, it also applies to the appearance of a script that is used for the writing system of a given literate community. Writing does not only represent language, it represents much more.

‘Sociocultural’, as used here, is an umbrella term. It does not collect all aspects that cannot be categorized into the systematic or processing fits, but the many aspects that can be broadly classified as being determined socially and culturally. This includes, among other things, political, religious, and technological factors. The sociocultural fit of scripts is inseparably tied to the sociocultural fit of the writing systems that employ these very scripts, much more so than the systematic and processing fits of scripts are associated with the linguistic and processing fits of writing systems. Whereas for these fits, the distinction between the material side of writing and the linguistic side of writing warrants an individual treatment, the material and the linguistic cannot be clearly separated for the sociocultural fit. One of the reasons is that sociocultural factors, not unlike processing factors, must be viewed from the perspective of users. Users, unlike (most) linguists, do not usually distinguish between scripts and writing systems. Without meta-grapholinguistic knowledge, users are oblivious to the commonalities and differences between various types of writing systems and their linguistic functions, and what they perceive, i.e. *see* as writing, more specifically as *their* writing, is the script they use. The ensuing strong connection between the graphetic and graphematic sociocultural fits renders it impossible to always straightforwardly determine whether a given factor concerns scripts, writing systems, or both. In this section, the main focus will be on those sociocultural factors that are influenced mainly by the materiality of writing, whereas broader sociocultural questions that concern both the graphetic and graphematic modules will be discussed in the context of Natural Graphematics in Section 3.3.3.

The most pressing sociocultural question regarding graphetics arises in the creation of writing systems for unwritten languages. Specifically, it concerns the often-decisive aspect of how the new writing system should look and *why* it should look that way. This includes the decision of whether an existing script is adopted or a new script is devised. It also subsumes the question of the materials that are available for writing in a given context, a question that is anything but trivial and can have major repercussions for the visual makeup of scripts. In this section, I will first address graphetic questions that pertain to the creation or reform of writing systems, and then I will turn to the sociocultural factors that come to the fore once an established writing system is in use.

Unseth (2005) claims that the visual appearance of a new writing system is always of critical importance, whether a non-literate community in need of a writing system wants to distance itself from a most often more dominant group or, to the contrary, convey membership to this group (strategies more closely analyzed in Section 3.3.3). Accordingly, two of the most common wishes that communities express in the process of literacy development are “We want the orthography to ‘look like’ another language” and “We do not want the orthography to ‘look like’ another language” (Cahill 2014: 13f.).

Very often, the first decision made is to adopt Roman script – a decision that is frequently influenced by hegemonic and technological factors, see below. Consequently, this choice of Roman script influences, bottom-up, the graphematics of the writing system. It appears reasonable to assume that the type of writing system most closely associated with Roman script is adopted along with it: the alphabet. Sometimes, not only the type of writing system is adopted, but also some of the graphematic values that the basic shapes have in a given donor writing system (e.g. English or French). Notably, although the adoption of a script and the adoption of graphematic relations are often connected, these processes are completely independent of one another. Thus, a script such as Roman script can be adopted and utilized for a different type of writing system than the one it is originally used for (cf. some Roman basic shapes used in the syllabic writing system of Cherokee, cf. also Section 2.2).

When the decision is made to devise a new script from scratch, the above-mentioned wishes of signaling distance or affiliation come to the fore. An apparent graphetic example is the “stroke formation of glyphs [= basic shapes, D.M.] in the Sinitic sphere” (Unseth 2005: 33), e.g. Chinese, Japanese kana, and Korean Hangul. The basic shapes of these scripts share visually salient features, and outsiders not literate in any of the writing systems employing these scripts could be led to believe they belong to the same set. This can be attributed, at least in part, to the fact that script creations from “scratch”, such as Korean Hangul, do not occur in a geographical, sociocultural, and political vacuum. Instead, communities always make decisions about a script for their new writing system “with a conscious awareness of their neighbors” (Unseth 2005: 33). Note that in the cited case of Japanese, the visual appearance of the kana inventories is not arbitrary, but due to the fact that the basic shapes of the kana scripts developed diachronically out of Chinese basic shapes (cf. Takagi 2019; Smith 1996: 210-213).

The choice of script is socioculturally charged because it is intimately tied to the question of how a community sees and identifies itself. As Abdelhay, Makoni & Makoni (2018: 98) note,

> script choice is not a neutral corpus-planning endeavour but, rather, is deeply associated with theological and political issues to the extent that script choices are often oriented towards the production of binary, socially fragmented spaces of identification.

An example of a complex history of script changes that demonstrates how scripts can be instrumentalized as tools for identification is the story of writing Azeri. For a writing system of Azeri, the script was changed three times in the 20th century alone. The first important script change came with a switch from "twelve or more" (Bahadori 1993: 10) ancient Azeri scripts to Arabic script, which occurred in the 7th century when Arabs arrived in Azerbaijan. This first script change was driven by cultural and religious motivations and had the effect of "inforcing Azerbaijan's link with Islam" (Hatcher 2008: 107). Crucially, "Arabic script presented many difficulties, not effectively representing Azeri phonetically" (Hatcher 2008: 107), which highlights how the linguistic and sociocultural fits can be in conflict. It also underscores that the switch to Arabic was not a pure script adaptation, but an adaptation of the type of writing system – an abjad – and along with it, even Arabic graphematic relations (cf. Section 2.2). The first major script change in the 20th century came in 1924 when due to a new Soviet policy, Arabic script was dropped and replaced by Roman script. Although this decision was promoted as part of a liberal language policy based on the premise that "everyone had the right to speak whichever language they wanted, privately or publicly" (Hatcher 2008: 107), and was supported by the intelligentsia of Azerbaijan, it had an ulterior political motive: to distance the people of Azerbaijan from Islam in order to "secularize Azerbaijani identity" (Hatcher 2008: 109). Quickly, the supposedly liberal character of the language policy faded, and in 1925, a decree "outlawed the importing of anything printed in Arabic script" (Hatcher 2008: 108). By 1928, in many villages, Arabic books were burned and being caught owning or hiding them could result in imprisonment or worse (cf. Hatcher 2008: 109). In the 1930s, the once progressive language policy of the Soviet regime changed further. A crucial, politically motivated event taking place in 1928 and exerting an influence on the situation in Azerbaijan was the switch from Arabic to Roman script in the Turkish writing system (cf. Wood 1929). Following this switch, the Soviet regime started to fear a pan-Turkic identity movement. As a result, in 1939, Stalin announced that for the Turkic languages of the Soviet Union, Roman script would be replaced with Cyrillic script. This marks the second major 20th-century script change for Azeri. Its main goals were "Russification and isolation between Turkic nations" (Bahadori 1993: 11). The third and final script change occurred shortly after Azerbaijan gained independence in 1991: only four days after signing the Alma Ata Protocol that dissolved the Soviet Union, the parliament in Azerbaijan voted for a return to Roman script (cf. Hatcher 2008: 111).

As this turbulent history of scriptual changes shows, scripts, and writing systems in general, are tools that are potentially instrumentalized by political forces. This is possible only because scripts carry in them deep cultural connotations. They are not only inventories of visual basic shapes – they always have their own history and indexically refer to cultures, religions, politics, nations, etc.

Technology also affects the sociocultural fit. It might not appear sociolinguistic in a narrow sense, and as briefly mentioned in Section 3.1.1, it is reasonable to ask whether technological factors justify the assumption of their own fit, the technological fit. The question of which technology (i.e. material, instruments) is available in a given community is not trivial. To the contrary, like other sociocultural factors, it can prove to be a decisive factor in the visual makeup of a script. Burmese script is a telling example of this (cf. Section 2.2.1.1), and it underscores the relevance of a paragraphetic perspective. At the time of the development of the script, what was available as a writing surface, and what was ultimately *chosen* to write on, was palm leaves. The round visual character of the script's basic shapes is a result of this choice. Even though the preliminary conclusions cited in the context of the processing fit suggest that curves might be easier to process than angles and straight strokes (cf. Section 3.2.2), cognitive and physiological human pressure was not the driving force behind the round shapes in Burmese script – the available material was. Availability of suitable writing material is driven by geographical and supply factors in the sense of "what material occurs naturally in a given region?". In creations of new scripts, script creators can only work with what is available. Similarly, in script adoptions, scripts for which sufficient technology is available are more likely adopted.

Not only technology in the sense of available materials is of central concern for the sociocultural fit, but also the technological advancement of a community, and in that context, the availability of modern technology such as computers, keyboards, fonts etc. It shapes modern literacy development to a tremendous degree. This is reflected, for example, in publications detailing the *Summer Institute of Linguistics'* (SIL) efforts to bring literacy to non-literate communities. Among the larger group of "non-linguistic factors", Cahill (2014: 9) highlights technical issues which "include printability and Unicode-compliance of every symbol [= basic shape, D.M.]". One of the reasons why Roman script is so popular in literacy development is that communities who gain literacy through a newly created writing system can immediately use all of the technology that is suitable for Roman script as long as the instruments are made available. This does not only include keyboards, smartphones, etc., but also the internet and social media, where, even though many other scripts can be used, Roman script is frequently employed, even for writing systems that are commonly written with other scripts (such as Greek, Arabic, Thai, etc.). For a writing system to not only be accepted by a community, but also to come and remain in continuous use, "[t]here needs to be a stable mode of production to enable local people to continue with literacy on their own" (Cahill 2014: 21).

Arguably, the option of creating a new script from scratch is nowadays often not considered because new shapes – even if they exhibit natural systematic and processing fits – are not immediately suited for technology, as new scripts are not encoded in Unicode, which would cut off many possibilities of using modern digital forms of communication. This is counterproductive in the context of creating a writing system whose main goal it is to enable written – this includes electronic – communication.

A bundle of phenomena and factors relevant for the sociocultural fit reveals itself in a given group's (or individual's) choice between either two (or more) scripts, visual varieties of scripts, or orthographies that coexist and are simultaneously available in a given community. These socioculturally charged choices can be subsumed under the heading of *biscriptality* (cf. Bunčić, Lippert & Rabus 2016). Biscriptality is defined as "the simultaneous use of two (or more) writing systems (including different orthographies) for (varieties of) the same language" (Bunčić 2016a: 54). In an effort to clarify, organize, and operationalize concepts and terminology of the sociolinguistics of writing, Bunčić (2016a) draws up a typology in which the various types of biscriptality are characterized (cf. Table 9).

Based on the type of opposition – understood in the Trubetzkoyan sense – between two scripts, Bunčić assumes privative and equipollent situations. (1) *Digraphia* is the situation in which there is a privative opposition between scripts, i.e. one script is lacking a feature that is present in the other script. Which of the two scripts is used in which situation is determined by (1a) *diaphasic* (pertaining to registers and style), (1b) *diastratic* (pertaining to social strata), (1c) *diamesic* (pertaining to the conceptual dimension of written vs. spoken established by Koch & Oesterreicher 1986), or (1d) *medial* (depending on the writing material) factors. By contrast, an equipollent opposition is present in cases in which two scripts are characterized by the presence of two distinct features, respectively, i.e. the feature [Hindi] for Devanagari as used for the Hindi writing system and [Muslim] for Arabic script as used for the writing system of Urdu (cf. Bunčić 2016a: 55). This type of biscriptality is termed (2) *scriptal pluricentricity*. It is determined by (2a) *diatopic* (i.e. geographical), (2b) *ethnic*, or (2c) *confessional*, i.e. *religious* factors. Finally, there are more complex situations in which there is no clear-cut criterion that can predict the choice of script. Bunčić (2016a: 60) calls these situations *diasituative* and gives the example of Serbian, where a variety of factors ("the number of participants in a communicative setting; the relationships among participants concerning age, education, sex, etc.; time and duration of the communicative act; the topic; the degree of publicity; and many others", Bunčić, 2016a: 61) can influence whether a writer will choose either Roman or Cyrillic script. This type of biscriptality is referred to as (3) *bigraphism*. Crucially, "scripts used in a bigraphic situation always carry additional indexical meanings" (Bunčić 2016a: 61).

The distinction between the subtypes of biscriptality, i.e. (1) digraphia, (2) scriptal pluricentricity, and (3) bigraphism, is based on sociolinguistic concepts. In addition to this dimension, Bunčić proposes a grapholinguistic dimension that distinguishes between the graphetic, graphematic, and orthographic levels.

All of the above remarks characterizing biscriptality were based on the level of scripts, as the different types of biscriptality always involve two (or more) distinct scripts such as Devanagari and Arabic script. Since scripts are the subject of graphetics, this implies that these types of biscriptality are located at the graphetic level. However, from the perspective of users, digraphia, scriptal pluricentricity, and bigraphism are graphematic: Bunčić (2016a: 64) explains that, for example, in a diagraphic situation, users might not be able to read both of the scripts which are in a private opposition. Accordingly, the substitution of one script for another in this situation is not merely a change of basic shapes, but a fundamental alteration of the visual appearance and linguistic makeup of the entire system which makes it "indecipherable to speakers" who do not read this other script. As Bunčić (2016a: 64) argues, "different scripts completely block communication". Take the example of script change in Azerbaijan discussed above: changing the script from Arabic to Roman not only changed the graphematic relations between basic shapes and phonemes but, fundamentally, the type of writing system: an abjad became an alphabet. In such a situation, users of a writing system are not required to familiarize themselves with new basic shapes that have the same graphematic relations of the old ones. Instead, they must learn a new system altogether. Situations in which, along with a script, the type of writing system is changed, are referred to as *intersystemic biscriptality*. However, it is important to note that in the example of Azeri, no two scripts were (officially) in use simultaneously, as one script was always replaced by another. This means that the case of writing Azeri is actually no fitting example for biscriptality, where scripts always coexist simultaneously. Nonetheless, it suffices to highlight that changing or switching scripts is not merely a graphetic matter, but a graphematic one. This also holds for a substitution of scripts that does not involve a change of the type of writing system, such as when Cyrillic is replaced by Roman, which are both used for alphabets. This latter type of biscriptality is called *intrasystemic biscriptality*.

Bunčić (2016a: 64) does propose an entirely graphetic level of biscriptality, which he calls the glyphic level. Its subtypes are, in analogy to the types characterized above, *diglyphia*, *glyphic pluricentricity*, and *biglyphism* (cf. Table 9). *Glyph* was, in Section 2.2.1.2, defined as a synonym of graph, which means it refers to the concrete materialization of a basic shape. Graphs can exploit the graphetic solution space of a given basic shape and are the locus of variation that allows and gives rise to different styles of handwriting or different typefaces. Accordingly, distinct glyphic variants such as *blackletter* and *roman* within Roman script are glyphic variants of the same script. These glyphic variants can, unlike the distinct scripts in the situation described above, both be recognized and read by users familiar with the script (in this case Roman script). Sociolinguistically relevant glyphic variants are typically not just different typefaces, but variants that are perceived as almost emblematic of a given sociolinguistic variable; examples are given below.

The third grapholinguistic level of biscriptality is orthographic. It differentiates between different types of standardization: an example is the variant <ss> used in the German variety of Switzerland instead of <ß> which is used in Austria and Germany. Its subtypes are *diorthographia*, *orthographic pluricentricity*, and *biorthographia*.

Table 9 provides an overview of the sociolinguistic and grapholinguistic dimensions of biscriptality and offers respective examples that are taken from the edited volume of Bunčić, Lippert & Rabus (2016).

Table 9: Types of biscriptality, adapted from: Bunčić (2016a: 67) with examples from Bunčić, Lippert & Rabus (2016)

grapholinguistic dimenstion / *sociolinguistic dimension*	**script** GRAPHEMATIC	**glyphic variant** GRAPHETIC	**orthography** ORTHOGRAPHIC
privative (diaphasic, diastratic, diamesic, medial)	digraphia diamesic (medial) digraphia in Medieval Scandinavia	diglyphia diaphasic diglyphia in Russia	diorthographia medial diorthographia in Novgorod
equipollent (diatopic, ethnic, confessional)	scriptal pluricentricity Hindi vs. Urdu	glyphic pluricentricity Orthodox, Muslim, and Catholic Cyrillic in Bosnia	orthographic pluricentricity Simplified vs. Traditional Chinese
diasituative	bigraphism Cyrillic and Roman for Serbian and "Serbo-Croatian"	biglyphism Blackletter and roman in German	biorthographism 'Classical' and 'Mistralian' spelling in Occitan

In the discussion of the creation of new writing systems, it became clear that the choice of a script is complex and subject to a variety of factors, many of which are sociocultural. However, in these cases, usually, once a choice is made, it is absolute, and no situations of biscriptality emerge. In contrast, the complex sociolinguistic situations of biscriptality as described in Bunčić, Lippert & Rabus (2016) offer different evidence for an investigation of what is socioculturally natural in writing. In these situations, there exist distinct variants that occur simultaneously in *one* language. Despite this *simultaneous* occurrence and use of different variants, it would be wrong to assume that users of these writing systems (always) have a free choice. As is evident from the table above, the choice of script, glyphic variant, or orthography is subject to a variety of factors. Diasituative situations are exceptions as in this case, one could speak of the possibility of a free choice, even if in that case, too, it is rather an intransparent bundle of deciding factors that can give the impression that, for example, the choice of a Serb to use Cyrillic is "free" when it is actually not. In sum, all of the factors listed in the "sociolinguistic dimension" column in Table 9 are crucial for an investigation of the sociocultural fit of scripts.

As an example, consider *medial biscriptality*. Here, the factor which affects the choice appears straightforward: the choice of a given script, glyphic variant, or orthography is connected to the respective material used for writing. In the case of medial diorthographia in Novgorod, for example, birch-bark documents were written in a vernacular orthography, whereas religious books used a standard orthography. The digraphia between Latin script and runes in medieval Scandinavia, too, might appear to be determined by the writing material. While Latin script is written with ink on parchment, runes are carved on wooden sticks or bones. However, this case is more complex, as the choice of material is itself determined by the intended function of the text. For texts that were meant to last, parchment and ink and, in consequence, Latin script were chosen, while in more ephemeral texts that could be discarded, wood or bones and, consequently, runes were used. A fine-grained analysis of the contexts in which these two scripts were used reveals that Latin script exhibits the feature [+distance] whereas runes do not, as they are associated with "spontaneity, intimacy with the addressee, expressiveness or privateness" (Bunčić 2016b: 76). Thus, the digraphia between Latin and runes is not medial, but diamesic.

Although it would be convenient for a theory of writing, the formulation of naturalness parameters for the sociocultural fit of scripts as done for the other fits is challenging. While the sociolinguistic dimensions listed in Table 9 appear as promising candidates, they are not themselves naturalness parameters. Instead, they are factors that affect a more general naturalness parameter that could be referred to as *situational adequacy*. The attribute 'situational' implies that the sociocultural naturalness of a script must be evaluated individually for each given situation. 'Situationally adequate' is obviously the most natural configuration at the level of system-independent naturalness. However, stating that scripts which are situationally adequate are most natural socioculturally is self-evident and not informative. This is where the multitude of diverse factors outlined above comes into play, which all determine *what* is perceived as situationally adequate. Additionally, while these factors are finite and similar for each situation, they are prioritized differently for each situation. In one scenario, technological factors pertaining to the material available might be central and render an angular script carved in wood most situationally adequate, while in a different situation, even if only wood was available as a writing surface, the adoption of Roman script can still be situationally most adequate for other, e.g. political reasons, overriding the factor of material. This all points to the fact that the sociocultural naturalness of a script must always be evaluated at the system-specific level.

For the sake of completeness, I want to mention briefly that the graphetic sociocultural fit cannot only be evaluated with respect to scripts as inventories of basic shapes, but also with respect to visual variation at the concrete level of graphs, which Bunčić's (2016a) grapholinguistic dimension of glyphic variants already emphasized. A possible question at this level is whether a given typeface is situationally adequate, such as Comic Sans in university professors' PowerPoint presentations (cf. Meletis in press b). What is central in this specific consideration is not the systematic or processing fits of the Roman script, but, considering the degree of possible visual variation within the graphetic solution spaces of Roman basic shapes, the specific appearance of the basic shapes of Comic Sans complete with the connotations that the typeface evokes. These connotations influence the contexts for which Comic Sans is deemed adequate or inadequate. In questions such as this, an additional level of complexity is added since situational adequacy is not a matter that can be settled by descriptive grapholinguistic analysis (nothing in the appearance of Comic Sans makes it inherently suitable or unsuitable for given situations), but instead a matter that is entrenched with (implicit) conventions and norms that users in a literate community negotiate among themselves. For this reason, this question will be addressed more elaborately in the context of a *Natural Orthography* in Section 3.4.

3.3 Natural Graphematics

Natural Graphematics is the second subbranch of Natural Grapholinguistics. It investigates naturalness in the graphematic module, i.e. naturalness with respect to the relations between visual units and linguistic units. In this subchapter, the three fits of Natural Graphematics will be treated: first, the (1) *linguistic fit*, which evaluates, descriptively, the quality of the semiotic structures that underlie writing systems. Among other things, the linguistic fit helps to assess whether a writing system fits the language it is used for. In the next step, the (2) *processing fit* is introduced. It is concerned with the question of how the formerly described semiotic structures in writing systems affect reading and writing processes. To achieve that, it will be necessary to analyze if and how the naturalness parameters of the linguistic fit, which were gained descriptively, affect cognitive processes. Lastly, in the context of the (3) *sociocultural fit* of the graphematic module, the focus will be on literacy development. Here, it will be shown that the sociocultural fit can override the linguistic and processing fits, proving that sociopragmatic considerations are an indispensable extralinguistic foundation of Natural Grapholinguistics.

3.3.1 Linguistic fit

Writing systems can be conceptualized as semiotic systems. As their core module, the graphematic module relates units from a linguistic inventory, a language, with units from a visual inventory, a script. The interpreter, a human writer or reader, is involved in the semiosis that conceives of graphemes as signs. These semiotic relations of the graphematic module are not only part of the writing system, but also a crucial part of the user's knowledge. It is not only graphemes but units of all graphematic levels – including subsegmental graphematic levels and larger levels such as the graphematic word level – that can be interpreted as signs. A semiotic analysis of this kind marks writing systems as perfect candidates for an evaluation of the "quality" of their inherent semiotic structures. This falls under what I term the *linguistic fit* (cf. also Sariti 1967: 29). It provides an answer to the question: how well does a writing system fit a given language? The naturalness parameters of NM (cf. Section 1.3.2) that are concerned with either the relationship between signans and signatum or the properties of a sign as a whole, can be transferred to and reconceptualized within Natural Graphematics (cf. Section 3.1.2.3 for preliminary examples). This reconceptualization constitutes the heart of the present section.

The linguistic fit is solely descriptive. While it assesses the semiotic structures of writing systems, it is not informative with respect to how these structures affect cognition, or in general, how users process writing systems. The processing fit, thus, must be evaluated in the next step. In original Naturalness Theory, these two fits appear to be inherently merged. In NM, it was explicitly assumed that the semiotic structure of signs affects cognitive processing. Structure and processing were interpreted as being inseparably linked. Consequently, a "good" semiotic structure automatically equaled a good cognitive fit which was claimed to facilitate processing. In my proposal of a Natural Grapholinguistics, this coupling of the linguistic and the processing fits is no longer regarded as a basic assumption (cf. also the discussion in Section 3.5.1). Thus, it remains to be shown whether semiotic structure – and particularly, which facets of semiotic structure, i.e. which naturalness parameters of the linguistic fit – bear on the processing of written signs.

Arguably, the linguistic fit could be more neutrally termed *semiotic fit* since it is interested in the semiotic structures of the graphematic module. By choosing to call it *linguistic fit* instead, a specific perspective is taken which foregrounds the question "does a writing system fit a given language?". Hypothetically, the opposite question "does a language fit a writing system?" could also be asked. However, since language is not only ontogenetically and phylogenetically primary, but writing as a modality is also fundamentally dependent on language, the perspective of language as a basis is taken – hence *linguistic fit*.

Natural Graphematics is located in part at a different level than NM, the subbranch of Naturalness Theory it is primarily modeled after. Morphology, as a subsystem of language, is a primary sign system, morphemes are primary signs. As such, they relate a phonological representation (= signans) with a meaning (= signatum). By contrast, morphographic writing systems such as Chinese are secondary sign systems: in a grapheme such as Chinese <家> *jiā* 'house', the basic shape represents a morpheme, which is itself a sign. The grapheme is thus a sign of a sign. In phonographic systems such as German, too, a sequence of graphemes such as <Haus> 'house' represents a sign: a morpheme. Accordingly, the German graphematic word <Haus> is also a sign of a sign. However, the individual graphemes of <Haus> have a different status: they relate basic shapes with phonemes, which, unlike morphemes, are not signs. Thus, phonographic graphemes are, much like the morphemes studied by NM, primary signs. Some naturalness parameters such as *(imagic) iconicity* cannot be evaluated for phonographic graphemes such as <s>: since the phoneme /s/ which <s> represents is not a sign since it lacks a signatum, it cannot be assessed whether <s> is iconic since /s/ has no meaning that could be iconically depicted, and as a mere signans, /s/ can also not be iconically depicted itself (with exceptions, cf. Section 3.3.1.2). The situation is expectedly different for the above-mntioned morphographic grapheme <家>. In this case, the signatum of the grapheme is a morpheme which has a meaning. Therefore, it can be evaluated whether this grapheme is iconic by evaluating whether the visual form of the basic shape resembles the (prototypical) visual shape of the object that the morpheme's meaning refers to, i.e. a *house*.

The fundamental difference between 'meaningless' phonography and 'meaningful' morphography boils down to the fact that for phonographic writing systems, some of the naturalness parameters cannot be evaluated, at least not for individual graphemes. With respect to larger graphematic units such as the graphematic word <Haus> 'house' in which the string of graphemes represents a meaning-bearing linguistic unit, such evaluations are possible even in phonographic systems. By contrast, for morphographic systems such as Chinese, the semiotic naturalness parameters of NM can be applied straightforwardly. This does not come as a particular surprise, as the theoretical and methodological apparatus of NM was tailored for morphology, and morphographic systems are based on morphology.

In the following subsections, I will sketch how the linguistic fit of writing systems can be evaluated one parameter at a time by discussing examples from writing systems of different types, predominantly Arabic, Chinese, German, Korean, and Thai, but also others. The parameters will be characterized concisely, and the focus will be on the question of which configurations of these parameters are more natural than others. In this context, it is necessary to highlight which semiotic graphematic structures are universally natural, which structures are natural for given language types and which idiosyncratic preferences are located at the system-specific level. Hereby, this section offers tools for a systematic investigation of the question whether “every language gets the writing system it deserves” (Frost 2012: 266), without giving a definite answer itself, however. This section also provides input for the discussion in Section 3.5.4 in which I will evaluate how the various naturalness parameters interact and where possible naturalness conflicts are located which give rise to type-specific or even system-specific solutions across the graphematic modules of the world’s writing systems.

Several different categories of parameters need to be distinguished: first, *paradigmatic parameters* vs. *syntagmatic parameters*. The parameter of transparency, for example, *paradigmatically* compares graphemes within a system with respect to how transparently they represent linguistic units such as phonemes and morphemes. It cannot capture phenomena that occur only in larger graphematic sequences, such as positional incongruency, i.e. when a graphematic sequence <abc> represents a phonological string /bac/. Here, the individual graphemes are transparent, i.e. paradigmatically transparent, but there is unnaturalness on the parameter of positional transparency which can only be conceived *syntagmatically*. A second necessary distinction is *intersystemic parameters* vs. *intrasystemic parameters*. Many of the parameters listed in the following can be both intersystemic and intrasystemic, depending on the perspective taken. For example, when the paradigmatic transparency of the German graphemes <f> and <v> is compared, transparency is interpreted intrasystemically. By contrast, when the transparency of German graphematics is compared with the transparency of Thai graphematics, transparency is read intersystemically. Some parameters can be reasonably interpreted only in one way: indexicality, for example, evaluates how natural indexical relations are between certain elements, e.g. how spatial proximity or distance transparently signal or opacify semantic textual coherence. This parameter can be applied most fruitfully in a comparison of texts, specifically textual arrangements or layouts. Arguably, at this higher-order graphematic level, different writing systems share the same resources to arrange texts, i.e. are equal from an intersystemic perspective. Intrasystematically, however, different texts from one system – e.g. German – can be compared.

In sum, this section showcases parameters that allow description and comparison of writing systems and sets the stage for an investigation of how these parameters affect the processing of writing systems.

3.3.1.1 Unit of representation

The parameter of *unit of representation* evaluates which type of linguistic unit should be the unit primarily represented by the graphemes of a writing system. Possible candidates are units of closed inventories such as phonological features, phonemes, syllables, or, to some degree, morphemes, but not words, sentences, texts, or discourses (cf. Meletis in press a). It would be tempting to resort to arguments of alphabetocentrism at this point, claiming that the possibility of representing segmental linguistic units makes a writing system more efficient, or to advocate the syllable as the most natural unit of representation since evidence from processing suggests it is the unit that is most efficiently processed (cf. Section 3.3.2.1). Graphematic modules can efficiently represent their underlying language systems without offering segmental information (i.e. representation of phonemes), and writing systems that are not syllabic can also be processed efficiently. Thus, descriptively, there is no such thing as a system-independent natural unit of representation. The crux of the question whether languages get the writing systems they deserve (cf. Frost 2012: 266), thus, lies not at the universal level of naturalness, but at the typological and system-dependent levels. Accordingly, it is a language's type, and to some degree, also its idiosyncratic features that determine which linguistic unit should be represented by graphemes in order to maximize the linguistic efficiency of a writing system. This means that language typology and writing system typology interact in crucial ways.

There are several features of languages that can influence which unit of representation is most natural. Some of these features are closely related to classifications made by morphological and phonological typology. They include, but are not limited to, the size of a language's phoneme inventory, the number of phonotactically licensed syllables, the degree of invariance of the shape of morphemes (this includes morphonology), the existence of consonant clusters and the degree of syllable complexity, the length of words, homophony, infixation and introflection, cumulation, fusion, and tones. Many of these features interact or are determined by one another, i.e. the number of possible syllables and homophony. I want to highlight the relevance of such features by discussing two specific writing systems: Chinese and German.

Chinese is most often classified as an isolating language. At a higher, more abstract level, it is uncontroversially classified as an analytic language. Typical features of analytic languages are (1) predominantly monosyllabic morphemes, (2) lexical tone, (3) extensive use of function words, and a (4) relatively fixed word order. All of these features apply to Chinese. Additionally, the phoneme inventory in Chinese is relatively small, and the phonotactics exhibit a low degree of complexity. This yields a relatively small number of possible syllables in Chinese. Since Chinese morphemes are monosyllabic, there is a large degree of homophony at the level of morphemes. Additionally, mostly due to the lack of inflectional morphology, the phonological representation of morphemes is almost maximally constant. This large degree of homophony is disambiguated by the fact that most words are bisyllabic, and it is further disambiguated by the existence of four lexical tones which roughly multiply the number of possible syllables by four. The question of whether Chinese could be written alphabetically has already been mentioned (cf. Section 3.1.2.1). Aside from claims to the alphabet's superiority or other external sociocultural factors, this question can also be settled on linguistic grounds alone – and, in the context of the *linguistic fit*, has to be. Writing Chinese alphabetically would drastically reduce the number of graphemes, since the unit of representation would be phonemes instead of the more numerous morphemes. However, a phonographic writing system would have to solve the problem of homophony, which, in a phonographically transparent system lacking any morphography, would lead to homography: in a completely transparent alphabetical system, everything that has the same phonological representation is also written in the same way. To disambiguate, morphographic information could be introduced to such an alphabet, but it is questionable how this can be reasonably done when one Chinese syllable often serves as the phonological representation of ten or more morphemes. A hypothetical syllabic writing system for Chinese encounters many of the same problems. The grapheme inventory would be smaller, since there are more morphemes in Chinese than syllables. In both alphabetic and syllabic versions of Chinese, the inclusion of tone – via tone markers, for example – would increase compositional transparency (cf. Section 3.3.1.6) but still would not disambiguate the meaning of morphemes which are homophonous even when tone is accounted for. The bottom line is that a phonographic writing system for Chinese would introduce a massive degree of morphographic opacity that would have to be dealt with secondarily, by introducing morphography. This appears highly counterproductive: why introduce a phonographic system only to make it more morphographic? At first glance, the only apparent benefit of a phonographic system would be the smaller number of units that need to be acquired to be literate in the system. The actual morphographic system of Chinese boasts a huge grapheme inventory, but it is morphographically transparent. Interestingly, it includes a certain degree of phonographic transparency via the phonological components included in its morphographic graphemes. One of the features of Chinese that could indeed be better accommodated in a phonographic system is lexical tone which is not represented in the morphographic system of Chinese. On the basis of these considerations, it is a justified question whether the cognitive cost associated with a large grapheme inventory is greater than a large degree of homography and morphographic opacity. However, it is a question that is not asked in the context of the descriptive linguistic fit.

German, by contrast, is a fusional language. It boasts a large number of consonant clusters both in initial and final syllable positions, and its syllable structure is generally complex. This makes a syllabic writing system unfeasible, as an enormous number of syllabic graphemes would have to be acquired. Due to morphological processes such as ablaut and phonological processes such as final devoicing, morphemes can change their form to some degree. Additionally, grammatical morphemes are cumulative, which means a morpheme such as {-st} encompasses, for example, the functions 2nd person, and singular. These are just a few of the features which would make writing German with a morphographic system cumbersome. In sum, it appears like the alphabet is indeed most natural with respect to the linguistic fit when it comes to a writing system for German.

These were only brief thought experiments. They effectively highlight that the type of a given language as well as the specific features of this language are highly relevant in an evaluation of which unit of representation is most natural. Of course, the unit that is actually represented in writing systems is not always determined on linguistic grounds, as factors such as the script adoption and the type of writing system the adopted script is used for as well as sociocultural factors often come to the forefront.

3.3.1.2 Iconicity: pictography and diagrammaticity

Ahead of an in-depth analysis of graphematic iconicity, I want to present some of the most basic semiotic facts about iconicity. These are based on Nöth's (2001) treatment of Peirce's views on iconicity. An icon, as a type of sign, is "defined according to the relationship between the sign and its object" (Nöth 2001: 18). More specifically, a sign is regarded as iconic if it resembles the concept of the extralinguistic referent it stands for.[293] Prototypical examples for icons are pictures, portraits, and realistic paintings. Icons are one of three types of signs; the other two types are indexes and symbols. I do not want to further define these types here (for indexicality, see below), but it is important to note that "[e]very language sign [and this includes written signs, D.M.], even an iconic or an indexical word is a symbol" (Nöth 2001: 19). This underlines that these three sign categories are not mutually exclusive, and more specifically, that all signs are always symbols. Consequently, every evaluation of linguistic iconicity is an evaluation of iconicity in symbols.

Linguistic icons are not genuine icons, but so-called *hypoicons*. A hypoicon is "only similar to its object, and it shares only some of its features with its object" (Nöth 2001: 19). Three subtypes of hypoicons are distinguished: (1) *images*, which exhibit a similarity to their objects, evidenced, for example, by onomatopoetic words such as "cuckoo"; (2) *diagrams*, which bear a structural or relational similarity to their objects, an example of which is *ordo naturalis* in "Veni, vidi, vici", where the ordering of linguistic signs in the utterance reflects the temporal sequence

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[293] As Nöth (2001: 20) argues, for Peirce, an object "is no object of external reality, no object that exists independently of the sign". The object is rather something "merely imaginable". Much like the *interpretant*, the sign constituted by the semiosis which is carried out by the interpreter, the object is also a sign, but it "precedes our interpretation [and] is less developed than the interpretant of the sign". For our purposes here, it suffices to treat the object as an abstract concept of extra-linguistic referents. Thus, the morpheme {tree} does not refer to any one tree that exists in reality, or even the sum of all trees that exist in reality, but to the mental concept that humans have of a tree. This mental concept is, of course, intricately linked to and affected by our perception of trees that actually exist in reality.

of how the events unfolded in reality (cf. also Section 1.4.2); and lastly, (3) *metaphors*, which are least iconic, as here, "[t]he ideas conveyed by the sign and the idea of its object are mediated by a third idea, the *tertium comparationis* between the tenor and the vehicle of the metaphor" (Nöth 2001: 21, emphasis in original), with the *vehicle* (or *source*) lending some of its attributes to the *tenor* (or *target*). In the well-known Shakespearean metaphor "All the world's a stage", for example, "stage" is the vehicle and its attributes are transferred to "world", the tenor. Another basic distinction that proves crucial for an evaluation of iconicity is the one between (A) *exophoric* and (B) *endophoric* iconicity, or, as Nöth (2001) paraphrases them, "form miming meaning" and "form miming form", respectively. The types described in the examples so far are instances of (A) exophoric iconicity, where signs "serve as icons of the world, and iconicity consists of a signans-signatum relationship" (Nöth 2001: 21f.). Since this type of iconicity is constituted by signs referring to something external (i.e. existing outside of language), it is sometimes also referred to as *referential iconicity*. The second type, (B) endophoric iconicity (also *relational iconicity*), by contrast, has to do with "relations of reference *within* language" (Nöth 2001: 22, my emphasis). Two subtypes of endophoric iconicity are distinguished by whether they function (B1) *syntagmatically* or (B2) *paradigmatically*. (B1) Syntagmatic endophoric iconicity is relevant for intratextual analyses: repetitions, parallelisms, alliterations, rhymes, etc. within texts are in syntagmatic relationships and can be syntagmatically iconic. On the (B2) paradigmatic dimension – which is more relevant for an investigation of Natural Grapholinguistics – endophoric iconicity is concerned with intrasystemic iconicity, i.e. iconicity within an entire system. As Nöth (2001: 23) notes, endophoric iconicity is closely related to the concept of diagrammaticity (see below). That the graphemes <m> and <n> are materialized by the visually similar basic shapes |m| and |n| and represent phonologically similar units (nasals only differing in one phonological feature) in virtually all alphabets in which they are used is an instance of endophoric diagrammaticity.

Based on these considerations, three types of iconicity can be regarded as central for an investigation of graphematic naturalness: (a) (exophoric) imagic iconicity in the form of *pictography*, (b) exophoric diagrammaticity in the form of structural relations between a grapheme and the object it represents, and (c) endophoric diagrammaticity as in the example of <m> and <n>, where there is a diagrammatic (and indexical, see below) relation between two units of the same system. I will give examples for all three types in the following, as well as some examples for more marginal types of iconicity not mentioned here.

(a) In a grapheme that is exophorically imagic, the signans visually resembles the object that the signatum refers to. This is the case in some morphographic graphemes, in which the signans visually resembles the signatum's referent. This situation is commonly referred to as *pictography*.[294] In the Chinese grapheme <木>, which represents the morpheme {TREE} that has as its signatum the concept of 'tree', the basic shape |木| visually resembles, to some degree, an actual tree. From a diachronic perspective, pictography has decreased drastically, so that synchronically, it has become an extremely rare feature of writing systems, which is reflected by the graphetic features of arbitrariness and abstractness (cf. Section 3.2.2.1). This decrease, in turn, is partially caused by human processing pressure, specifically the fact that abstract shapes are easier to produce (cf. Section 3.2.2). Boltz (1986: 426) mentions another reason for the decline of pictography which is dependent on the structure of language, and, thus, relevant for the linguistic fit of pictography:

> Clearly such a primitive device such as drawing a picture to represent the intended word will soon prove unable to cope with even the simplest abstractions, much less with the manifold semantic complexities of the whole language. At this initial stage if something could not be depicted directly, it could not be written.

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[294] Cf. Boltz (2006) and Jespersen & Reintges (2008) for criticisms of the term and concept *pictography*. Like Behr (2010: 291), I use the term here "for easier cross-reference to the sinological tradition" and other philological traditions as well as to make pictography visible and comparable across writing systems.

Accordingly, pictography, or imagic iconicity, is unnatural with respect to the linguistic fit of writing since, as Boltz observed, it cannot handle the semantic richness exhibited by language (cf. also Tversky 1995: 34). How should abstract notions such as "freedom" or "love", not to mention function words, be depicted pictographically?

Another special characteristic of pictography is that it lies in the eye of the beholder in that it is constituted by the interpreter (cf. Ding 2005: 277). As such, it is not truly a descriptive category, as it depends on the interpretation of humans. In this vein, one could argue that description is *always* subjective as it is always, in some way, determined by the descriptor. Consequently, pictography is located somewhere between the linguistic and processing fits: it is constituted by the perception of users, which, however, does not reveal anything about how it affects processing. What users regard as pictographic in the contemporary writing system of Chinese was tested in a study by Xiao & Treiman (2012). Participants who did not speak (or read) Chinese were given a word or phrase in English and were presented two distinct basic shapes taken from Chinese script which were equal with respect to the number of strokes they included. Participants were then instructed to decide which of the Chinese shapes corresponded to the meaning given in English. As the participants did not speak or read Chinese, they were not capable of linking the basic shapes to the respective Chinese morphemes and phonological representations they usually represent graphematically. However, before this task, they were given the information "that Chinese characters tend to look like what they mean and that they could look for similarity between the appearance of characters and the meaning" given in English (Xiao & Treiman 2012: 957). The results suggest that only 15 of the over 200 basic shapes that were presented were deemed pictographic at above chance level. They are |爪| for *claw*, |凹| for *concave*, |内| for *inner-*, |贝| for *shell*, |气| for *air*, |川| for *river*, |个| for *individual*, |丁| for *man*, |小| for *small*, |耳| for *ear*, |田| for *field*, |三| for *three*, |门| for *door*, |雨| for *rain*, and |云| for *cloud* (cf. Xiao & Treiman 2012: 957). One of them, |三|, is actually an example for a different type of iconicity, exophoric diagrammaticity, see (b) below. It is the only one associated with an abstract concept.

As mentioned above, in the history of writing, pictography decreased. Thus, it was a more prevalent feature in ancient writing systems than it is in modern writing systems. Take Egyptian hieroglyphs or Mayan script as examples, both of which retained pictographic components, but, very similar to Chinese, gradually introduced arbitrary phonographic components as well (cf. Kim 2011: 187).

For phonographic graphemes, which are primary signs, the situation is more complicated. Here, as outlined above, phonemes serve as signata of graphemes. Since phonemes do not have a referent (or an object they refer to), pictographic graphemes would have to iconically represent the phoneme itself. Arguably, there is no way of truly iconically representing in a visual modality an acoustic datum (or a theoretical abstraction of said datum), since visual vs. acoustic forms of data transmission differ fundamentally. Diagrammatically (see below), such a representation would be possible by means of spectrograms or oscillograms in which the features of a phoneme (or more specifically a phone) in the context of the continuous stream of speech are visualized, but not the phoneme itself.

In the context of phonographic pictography, Hangul is a special case. In this script, the graphemes' basic shapes are formed to pictographically resemble the place of articulation of the phonemes they represent (cf. Kim 2011). This property of the Korean writing system serves as the basis for its typological classification as *featural* (cf. Sampson 2015; Section 2.3.2), as the smallest type of linguistic information graphematically represented is the shape of the speech organ and the articulatory gesture during the production of a phoneme (cf. Kim 2011: 181), which, in terms of phonological features, is referred to as *place of articulation*. Even if the pictography exhibited by Hangul does not play a major role in the use, i.e. processing of the writing system – to my knowledge, there are no studies that show whether L1 or L2 users of Korean are aware of the iconicity while reading, and it is questionable whether this feature affects the processing fit unconsciously –, this pictography lends the writing system a high degree of endophoric diagrammaticity (see below). This is due to the fact that their exophoric iconicity results in a situation in which shapes that refer to similar phonemes (e.g. bilabials) are visually similar.[295] In other words, linguistic similarity is reflected in visual similarity.

(b) The second type of iconicity relevant in writing is exophoric diagrammaticity. It also occurs in Chinese. However, the graphemes exhibiting it, classified as a group called *zhǐshì* 指事 'indicating things' according to the six-part *liushu* nomenclature (cf. Gong 2006: 40), are relatively few. The most-cited examples include the graphemes <一>, <二> and <三> which represent the numerical concepts *one*, *two*, and *three*, respectively, as well as <上> and <下> which refer to *above* and *below*, respectively. The concepts of different quantities or different locations/directions cannot be represented in a straightforward pictographic way since they do not refer to concrete objects the same way *tree*, *door*, or *claw* or any of the others named above do. However, diagrammaticity can still be established: the increase of numerical value is visually represented by the increase of the number of strokes, and spatial concepts are visually represented through a structural analogy (the full-length horizontal stroke being below which represents *above* and the full-length horizontal stroke being on top meaning *below*). This type of diagrammaticity can also be combined with the pictography described in (a), for example in the grapheme <本> *běn* 'root', where a stroke at the bottom of the basic shape representing *tree* serves to diagrammatically indicate something at the bottom or below a tree: a *root*.

(c) The third type of iconicity relevant for the evaluation of the linguistic fit of writing is paradigmatic endophoric diagrammaticity, or relational diagrammaticity. It is the most important type of iconicity for a synchronic analysis of modern writing systems of the world. In NM, it was referred to as *constructional iconicity* (cf. Section 1.3.2). As it subsumes a range of heterogeneous phenomena, it is a very broad type. Generally, it refers to the relation between two signs in which a difference in the structure of their signata is reflected by a structural difference in their signantia. When singular *artist* is pluralized as *artists*, it is not only the conceptual meaning that "increases" (from 'one artist' to 'more than one artist'), but also the signans, as one grapheme, <s>, is added to the graphematic word. In English, this corresponds with the increase of phonological material in the spoken form of the plural, which renders the written plural less evidently a form of truly graphematic diagrammaticity, but possibly only a reflection of the diagrammaticity already evident in phonology. Take French, however, where the equivalent, *artiste*, is pluralized as *artistes*, for both of which the phonological representation is /aʁ.tist/. In this case, the grapheme <s> serves as a plural marker and establishes a diagrammatic relationship dependent on the singular and plural signs as two elements of a graphematic system. This relationship is independent of the respective phonological representations, which are not diagrammatic. These examples of diagrammaticity due to pluralization concern – in non-morphographic writing systems – larger graphematic units such as graphematic words, but diagrammaticity exists also at lower levels between the individual graphemes of a writing system. This latter type of segmental graphematic diagrammaticity was already introduced above with the example of Korean Hangul, but it is, in principle, the same for every writing system. In the following, I want to illustrate it by focusing on the groundbreaking work of Beatrice Primus.

In her "featural analysis of the Roman alphabet" which she also calls "grammar of letters", Primus (2004; 2006) analyzes the elementary forms of the lowercase basic shapes of Roman script graphetically, and, in a next step, graphematically, focusing on their linguistic, and more specifically, phonological correspondences (for a critical overview of Primus's approach, cf. Me-

[295] The graphemes of Korean could exhibit diagrammaticity also if the individual shapes were not to pictographically represent the place of articulation but were instead designed arbitrarily. The decisive criterion for diagrammaticity is that similar linguistic units are depicted similarly in visual terms, and this is possible also for arbitrary basic shapes and their relations with one another. In the case of Korean, however, it is *because* of the pictography that diagrammaticity is constituted, i.e. diagrammaticity is a byproduct of pictography. See the diagrammaticity of Roman script below for an example in which pictography does not play a role.

letis 2015: 66-76). Primus aims to show how certain visual features of elementary forms that constitute the basic shapes correlate with phonological features, and how, if these visual features are analyzed compositionally, their sum equal the phonologically featural makeup of the phoneme that a given basic shape represents.

The first step in Primus's analysis is the segmentation of lowercase basic shapes into their respective elementary forms (cf. Section 3.2.1). The elementary forms that result from this segmentation are not all of equivalent status. Following Brekle (cf. Section 3.2.2), Primus identifies two different types of elementary forms: *heads* (in Brekle's terms, *hastas*) and *codas*. In |d|, the vertical stroke |l| is the head and the smaller curved stroke |c| is the coda. One of Primus's central observations is that heads are always vertical and obligatory and can – but do not have to – exhibit the feature [+length], whereas codas are optional, can be – but do not have to be – vertical and never exhibit the feature [+length] (cf. Primus & Wagner 2013: 41, see also Figure 42). At this point, I do not want to reproduce the specific form-function correlations as described in detail by Primus, but I want to argue, in broad strokes, how impactful her discovery is. When it comes to the phonological feature of *place of articulation*, for example, the features of the basic shapes' heads are revealing: basic shapes with a long and straight head as in |p, t, k, b, d| are in graphematic relationships with plosives, basic shapes with long but curved heads such as |f, v, w, s| with fricatives and basic shapes with non-long heads as in |m, n, r| with sonorants (cf. Primus & Wagner 2013: 44). In the resulting graphemes, at least one feature of their basic shapes' heads, i.e. the visually dominant descenders and ascenders in <p> and <t>, marks their diagrammaticity: [+length] (for a discussion of the role this feature plays for the demarcation of graphematic syllable structure in alphabets, cf. Section 2.2.2.3).

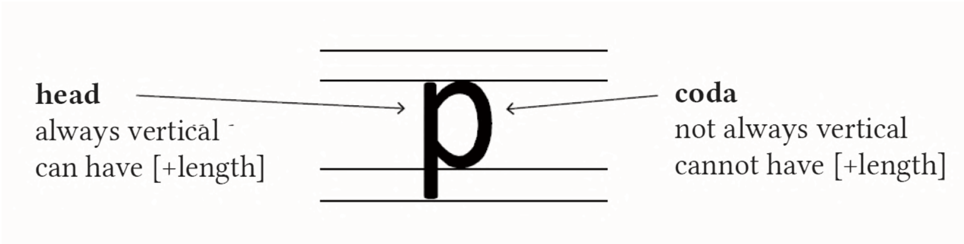

Figure 42: Head and coda structure of |p|, from: Berg, Primus & Wagner (2016: 339)

One of the criticisms that have been voiced against Primus's findings is that Roman script is used for so many different alphabets, and that, for this reason, her analysis cannot possibly account for all of the graphematic relations that the basic shapes partake in across alphabets (cf. Rezec 2010: 345f.). With respect to this criticism, it must be noted that the compositional value of the form-function correlations of a basic shape's elementary forms does not equal the full phonological representation of the phoneme it represents, but rather an *underspecified* phonological representation. The featural configuration of a basic shape corresponds with a "canonical phonological value", i.e. an underspecified phonological feature bundle. This allows for a single basic shape to be in a graphematic relationship with a number of phonologically related phonemes (cf. Primus 2006: 21). Primus & Wagner (2013: 46) provide the example of |j|: in this basic shape, the head is long, left-oriented and not straight. On the basis of the assumed form-function correlations, these features merely point to a fricative produced in the back of the oral cavity. The exact phonological value of the basic shape, however, can vary across writing systems: in German *jeder* 'everyone' it corresponds with /ʝ/, in French *jean* 'jeans' with /ʒ/. There might be exceptions to this, however: in the – admittedly – unlikely event that Roman script is adopted for a writing system *without* any of the graphematic relations from its donor writing system, graphematic relations could be (re-)assigned randomly and the diagrammaticity just outlined would be 'destroyed'.

What this example ultimately shows is that the systematic fit (cf. Section 3.2.1) of Roman script, which was described entirely independently from the graphematic relations that the basic shapes partake in, can be graphematically functionalized diagrammatically: when the visual similarity of individual basic shapes, which stems from the fact that they share the features of a given script as a visual system, is translated to graphematic similarity. In other words, diagrammaticity is established when visual similarity indicates linguistic similarity. The most natural configuration on the parameter of paradigmatic endophoric diagrammaticity is thus the complete and transparent reflection of linguistic similarity in visual similarity. If, by contrast, the systematic fit of a script is not linguistically functionalized or only functionalized to a small degree, the possibilities that the existing graphetic naturalness offers are 'wasted' at the graphematic level. Consider Thai: many basic shapes in Thai are strikingly similar visually, and there are many pairs or groups of basic shapes within the script that only differ minimally (cf. Cooper 1996). In some cases, visual similarity is functionalized, for example in the graphemes <บ> and <ป>, which represent /b/ and /p/, respectively, i.e. phonemes differing in one feature, [±voiced]. The exact same visual difference between two basic shapes is not functionalized analogously in <พ> and <ฟ>, which represent /p^h/ and /f/, respectively. In these two pairs of graphemes, the same type of visual modification is not accompanied by the same type of linguistic relationship between the represented phonemes. Thus, the visual modification is not diagrammatic throughout the writing system. Note, however, that the two latter graphemes <พ> and <ฟ>, low class consonant graphemes, are in a diagrammatic relationship with <ผ> and <ฝ> which also represent /p^h/ and /f/, respectively, but are high class consonant graphemes.[296] In the relation between these four graphemes, 'orientation of the knot' is diagrammatic, with [loop on the right][297] signaling *high class* and [loop on the left] signaling *low class*. Both diagrammaticity and non-diagrammaticity are abundant in the writing system of Thai, but all instances of diagrammaticity are only local, i.e. pertain only to pairs or groups of graphemes, but not the entirety of the grapheme inventory.

Diagrammaticity interacts crucially with another type of naturalness parameter, indexicality (see below). In the German writing system, for example, graphemes that are embodied by basic shapes with straight strokes as descenders or ascenders (such as <p> and <k>) index and evoke each other.

To conclude, I want to emphasize that the above-mentioned types of iconicity cannot be separated neatly, as they often occur simultaneously. Take |木| and |森|. Here, although it was not included in the list Xiao & Treiman (2012) gave, there is a (subjectively perceived) pictographic similarity of the respective basic shapes with a single tree and three trees, which renders these basic shapes pictographic. Simultaneously, they are exophorically diagrammatic since they roughly depict the increase of real substance from a single tree to a concept such as 'woods' as it would look like in reality. Finally, at the graphematic level, used as graphemes, <木> and <森> are endophorically diagrammatic since the increase in visual substance in the signans diagrammatically reflects the increase from linguistic singularity to plurality. While for the linguistic fit of a writing system, exophoric imagic iconicity and exophoric diagrammatic iconicity are only of marginal relevance, endophoric diagrammatic iconicity is central.

3.3.1.3 Indexicality

To describe how the naturalness parameter of indexicality can be reconceptualized grapholinguistically, it is useful to reconsider how it was defined in NM and Natural Textlinguistics. In NM, so-called "[i]ndexical force is the function of the major/minor proximity relating index and indexed sign both in the phonological sequence and in the hierarchy of content" (Crocco Galèas 1998: 77). Lexemes are seen as indexed signs or indexed signata, and there exist different types

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[296] In the writing system of Thai, there are three so-called 'consonant classes' to which consonant graphemes are assigned: high, middle, and low consonants. The class of a consonant grapheme is important for the assignment of tone to the written syllables of Thai (cf. Haas 1956: 10f.).

[297] In typographic terms, the loop in |พ| is called *front-first loop*, whereas the loop in |ผ| is referred to as *back-first loop* (cf. Punsongserm, Sunaga & Ihara 2017: 7).

of indexing signantia: the most natural of these are derivational affixes, since they are contiguous to the base and “denote the lexical value” of the indexed signata, i.e. lexemes (Crocco Galèas 1998: 77). Less natural are, for example, inflectional affixes, as these do not affect the lexical meaning of the indexed signatum, the lexemes, but only the grammatical meaning. Aside from the factor of how much indexes affect the lexical meaning of the indexed signata, distance to an indexed signatum and position within a sign play a crucial role for the different naturalness values of indexicality: inflectional affixes are claimed to be more natural if they are spatially located to the right of the indexed signata, for example.

In the subbranch of Natural Textlinguistics, indexicality was one of the most prominent parameters (cf. Fludernik 1996: 322; Section 1.4.2) as it focused on intratextual relations between elements of a text. Here, too, the type of index and its relative location play a role. In this context, anaphoric indexes such as personal pronouns that refer back to earlier elements of the text (which should not be positioned too far away) such as proper names were claimed to be most natural. How could, based on its interpretation in NM and Natural Textlinguistics, indexicality be modeled for the graphematic module?

Indexicality is, together with some aspects of figure—ground (see below), one of the parameters that work best on higher hierarchical levels of writing, that is, not the level of graphemes, but the levels of graphematic words, graphematic sentences, etc. Indeed, indexicality works best for entire texts, in which it is evaluated intra-textually. This type of high-level graphematic indexicality was already foreshadowed by Dressler (1989: 48-49) in the context of Natural Textlinguistics, when he discussed footnotes, endnotes, bibliographies etc. as examples of indexicality. For these types of textual elements, the position within the entire text plays a crucial role, and more specifically, their spatial relationship (measured in proximity or distance) with the running text. To provide an example, a simple assumption that can be made with respect to indexical naturalness is that footnotes, as indexes or indexing signantia referring to the main text, are more natural than endnotes. For endnotes, readers have to turn the pages to the end of a book, chapter, article, etc. to read the notes, whereas for footnotes, they “only” have to move their eyes to the bottom of the page. Thus, in the vein of Naturalness Theory, there is less effort involved in processing footnotes than endnotes because they are *closer* to their indexed sign. This is, of course, just one example, and in fact, it does not evaluate the linguistic fit of indexicality, but the processing fit. A full-fledged theory of textual indexicality must identify all of the relevant elements within a text as a closed system and then investigate their indexical relationships. With respect to distance, as the footnote example already implies, proximity is more natural, and with respect to position, anaphoric indexes, e.g. indexes that appear after their indexed signata, are more natural than cataphoric indexes. Additionally, precise indexes are more natural than imprecise indexes: an imprecise index would be “see above”, while a precise index would be “cf. Chapter 2”. Even more precise are footnote numbers that are positioned directly after the word or sentence that the content of a footnote refers to. All of these indexes are, as mentioned, intra-textual, which makes them endophoric. An example for exophoric indexes are references to other works occurring in a text, e.g. references such as “Dressler (1989)” in the present text. Again, a specific reference is more natural than something along the lines of “in the literature on Natural Textlinguistics”. Position, distance, and specificity are thus relevant subparameters for the evaluation of the descriptive naturalness of endophoric indexicality.

3.3.1.4 Transparency

Transparency is, arguably, the most important semiotic parameter in the evaluation of the linguistic fit. Unsurprisingly, it is the parameter that is most elaborated in the literature, although predominantly from a processing perspective (which will be discussed in the context of the processing fit, cf. Section 3.3.2.4). Transparency, here, deals with the analytical direction signans → signatum, in the case of graphematics: visual unit → linguistic unit. It is, thus, interested in *recoding* the visual input (cf. Neef 2005). Descriptively, this translates to an investigation of the question: which linguistic unit(s) does a given basic shape graphematically represent? In the German writing system, for example, <f> is transparent. It is *always*, independently of the graphematic context it occurs in, recoded as /f/. This grapheme, thus, is maximally transparent, i.e. exhibits the most natural value on the parameter of transparency.

Based on Neef's (2005) in-depth application of his recoding model to the German writing system, Neef & Balestra (2011) develop a measure of quantifying graphematic transparency (for a review of other measures, cf. Borleffs et al. 2017). It is based on the premise that for the graphematic modules of different writing systems, there exist different types of relevant correspondence rules. In phonographic writing systems, a correspondence rule is defined as the relation of a basic shape to the phoneme(s) (in the authors' terminology "phones") that it represents. Based on their complexity, correspondence rules are assigned different numerical values, and the minimal value is 1. If a basic shape represents only one phoneme (as |f| in German), this is modeled as a correspondence rule with the numerical value of 1. In the end, the values of all correspondence rules of a grapheme inventory are added up and divided by the number of basic shapes. This results in the so-called *gt-value*, the value of graphematic transparency. The first gt-value that Neef & Balestra (2011) calculate is for German. It is based on Neef's (2005) detailed analysis of the graphematic module of the German writing system which includes a description of correspondence rules. To illustrate how gt-values of different systems can be compared, Neef & Balestra (2011) additionally calculate the gt-value for the graphematic module of Italian based on a number of preliminarily assumed correspondence rules. The gt-value they calculate for German is 2.05, the value for Italian is 1.36. The Italian value is much closer to the minimal value of 1, which is simultaneously the most natural value of transparency with respect to the linguistic fit. The graphematic module of Italian is, thus, descriptively more natural than the graphematic module of German on the parameter of transparency.

Neef & Balestra's proposal represents a remarkable starting point for a general evaluation of graphematic transparency, as it provides a useful tool for the comparison of the graphematic modules across writing systems. The application to other alphabetic writing systems or writing systems of other phonographic types appears straightforward: for every writing system, be it an alphabet, an abjad, an abugida, or a syllabary, system-specific correspondence rules must be formulated. A challenge, in this context, could be assigning numerical values to different types of correspondence rules across different types of writing systems. A universal repertoire of correspondence rules and numerical values that every writing system can draw from is definitely a desideratum, and Neef & Balestra (2011: 114) remark themselves that "[w]riting systems can be compared with respect to the subset of types of correspondence rules that are relevant for them and with respect to the quantitative role the different rules play". One further restriction of the recoding model on which this type of gt-calculation is based on is that it only considers individual, segmental written units, while sequences (except for fixed letter combinations, Neef & Balestra 2011: 121f.), e.g. graphematic syllables, graphematic words, etc. are not taken into account by the overall gt-value of the system. In my conception of a Natural Graphematics, this distinct question of compositionality is investigated by a different parameter, *compositional transparency* (cf. Section 3.3.1.6).

In the following, I want to sketch how the described method of calculating a gt-value can be applied to writing systems which are typologically non-alphabetic and present other approaches of evaluating graphematic transparency.

As already mentioned, abjads such as Arabic and Hebrew should pose no problems for the above-described calculation of a gt-value. The fact that short vowel phonemes are not represented in writing is not a problem since it does not interfere with graphematic transparency at the level of individual graphemes, but the level of compositional transparency. As long as the individual graphemes are paradigmatically transparent, the gt-value will be natural. In cases in which the short vowels *are* written in Arabic and Hebrew, they are, in fact, transparent. An aspect that is specific to Arabic is the consideration of positional allographs, which is a feature that highlights Neef's insistence to work with the concept and term "letter" instead of *grapheme* as questionable (cf. Section 2.2.2.1). The positional allographs of Arabic are, as the term *allograph* already reveals, not individual units but merely variants of one grapheme (cf. Section 2.2.2.2). This means that one correspondence rule should suffice for one grapheme, and it is not necessary to assume different rules for the different basic shapes that depend on their position within a word. The same applies to <σ/ς>-allography in Greek. These instances of allography, from a graphematic point of view, do not behave differently than, e.g. <f> in German. Unlike Arabic graphemes or <σ/ς> in Greek, German <f> does not change its basic shape depending on the position it occurs in, but, like Arabic graphemes or <σ/ς> in Greek, regardless of its position, it represents the same phoneme. Positional allographs of this kind, thus, do not affect graphematic transparency. It remains to be seen, however, whether they are relevant for graphematic *uniformity* (or, in Neef's terms, *orthographic transparency*, see below).

An abugida that deserves special attention is Thai, which is sometimes claimed to be "the most complicated writing system".[298] It poses two challenges for the calculation of the gt-value described above: (1) it marks tone in a complex, graphematically suprasegmental manner. (2) Phonotactically, only a restricted number of consonant phonemes (/p, t, k, m, n, ŋ, w, j/) are licensed in syllable-final position whereas graphematically, all consonant graphemes can be written in that position. For this reason, graphemes switch their graphematic relation in syllable-final position: they cease to represent the consonant phonemes they represent in other positions, and are instead reassigned to represent one of the phonotactically licensed phonemes. This tampers severely with transparency, but it does so only in specific positions. These two aspects of Thai call for a clarification of how Neef & Balestra's (2011) method of calculating a gt-value could be extended or modified to account for them.

(1) When segments are treated individually, the fact that Thai boasts six basic shapes or graphemes[299] (|ฐ,ฑ,ฒ,ถ,ท,ธ|) for syllable-initial /t^h/ should not pose a significant problem for transparency (but ample problems for uniformity). Each of these shapes is in a graphematic relation with /t^h/. However, the resulting graphemes are members of distinct classes (high, middle, and low consonant classes). Their class membership is one of the multiple factors that together contribute to the assignment of tone to written syllables. Thus, in total, the informational load of these consonant graphemes is richer, they are not merely in graphematic relationships with consonant phonemes. Tone assignment is suprasegmental, however, which means it cannot be grasped by the paradigmatic parameter of transparency, and is, as some of the phenomena described above, treated by the parameter of compositional transparency instead (see below).

(2) While this type of suprasegmental tone marking does not affect the gt-value, the second problem does: the basic shape |ร|, is, in syllable-initial and syllable-medial position, in a graphematic relation with the phoneme /r/. However, since /r/ is not licensed as a syllable-final phoneme in phonological syllables, and |ร| can still be written in this position in graphematic syllables, the graphematic relation of |ร| is "redirected" to a graphematic relation with /n/ syllable-finally. Thus, <ร>, as a grapheme, is not completely transparent and must have (at least) a gt-value of 2, even if the change in graphematic relations is perfectly predictable from the position the grapheme occurs in. The situation is the same for all graphemes that are not in graphematic relations with the syllable-final phonemes /p, t, k, m, n, ŋ, w, j/; all of their values, e.g. /r/, are "redirected" to one of these eight phonemes in written syllable-final positions. This increases the overall complexity and gt-value of the graphematic module of Thai.

[298] Cf. https://www.youtube.com/watch?v=gKVtpCByEy4 (November 27th, 2018), a video titled "World's Most Complicated Writing System".

[299] A highly complex question that I cannot answer within the limited scope of this thesis is whether the basic shapes that represent the same grapheme but are assigned to different graphematic consonant classes are allographs or distinct graphemes.

Another feature that cannot be captured by the paradigmatic parameter of graphematic transparency is linearity: in Thai, the sequence and order of graphemes does not always straightforwardly correspond to the sequence and order of phonemes that they represent. This is because of so-called misaligned vowels, vowel graphemes that are positioned to the left of consonant graphemes but that, in the phonological representation of the CV sequence, follow the consonant phoneme: a graphematic sequence such as <VC>, thus, is in a graphematic relationship with a phonological syllable /CV/. Idiosyncrasies of writing systems like this feature which add positional opacity to the graphematic module are treated by the syntagmatic parameter of *positional transparency* (see below).

Aside from different types of phonographic correspondence rules, how can correspondence rules in morphographic Chinese be modeled? As expected, various features of Chinese are not accounted for by the correspondence rules as described by Neef & Balestra (2011).

To start out with a simple difference: instead of phonemes, the morphographic graphemes of Chinese represent morphemes. If a well-known measure closely associated with graphematic transparency, *orthographic depth* (cf. Section 3.3.2.4), which is usually interpreted phonologically and employed to distinguished shallow (= transparent) from opaque (= intransparent) systems, is extended to also account for morphographic orthographic depth, "the Chinese script [in the sense of writing system, D.M.] is quite shallow – especially in comparison to alphabetic writing systems" (Handel 2013: 33) since Chinese graphemes are overwhelmingly transparent.

As the naturalness parameter of transparency is concerned with graphemes, a question already discussed in Section 2.2.2.1 concerning graphemes in Chinese needs to be critically reevaluated: are the "characters" of Chinese, i.e. basic shapes that occupy segmental spaces, the graphemes, even if they are complexly structured? Or are subsegmental components – both phonological and semantic components – the graphemes? As I argued, the subsegmental components are undeniably functional in that they correspond with linguistic information of some sort, whether a semantic field or a – in most cases only approximate – pronunciation. However, their correspondences are not stable, and they do not represent linguistic *units*. They are parts of complex graphemes. These complex graphemes, like simple graphemes, represent morphemes. At this holistic level, correspondence rules for the graphematic module of Chinese are almost maximally transparent: each grapheme (with very few exceptions) represents one morpheme. For example, a basic shape such as |妈| refers unambiguously to the morpheme {mother}, with the phonological representation *mā* in Mandarin (and other phonological representations in other varieties of Chinese). In a superficial analysis of this sort, the graphematic relations of the subsegmental components are disregarded, in this example the radical for "female" and the phonetic component |马| which derives originally from *mǎ* 'horse'. However, graphematic transparency can also be evaluated at this subsegmental level when the correspondences of every semantic component and every phonetic component are evaluated. Are the subsegmental graphematic components as transparent as the complex graphemes they help constitute? They are not. Both types of components – phonological as well as semantic – are not completely transparent (which was also one of the reasons why they are not treated as graphemes). This means that an evaluation of graphematic transparency that accounts for the transparency of these subsegmental components as well as the compositional values of the complex graphemes they constitute will result in a much more unnatural gt-value for the graphematic module of Chinese than a holistic analysis which does not break up complex graphemes into its components. In order to make possible a comparison of different grapheme-based gt-values, from a descriptive perspective, the holistic method is reasonable. This, however, does not necessarily reflect psychological reality, since, in processing, the subsegmental components are relevant entities. Note that an investigation of subsegmental graphematic transparency is also possible for other writing systems: in German, for example, or any other writing system employing Roman script, one could analyze how transparently the subcomponents of basic shapes represent phonological features (cf. Primus's analyses above). The same is true for the correspondence (or non-correspondence) of visual features and linguistic features in Thai.

An additional problem with an evaluation of transparency that takes into account phonological components is their applicability across varieties of Chinese: they give more or less reliable pronunciation clues only in Mandarin, while other varieties such as Cantonese cannot rely on them. This is relativized by the fact that children of all varieties are instructed in Mandarin in school (cf. Anderson et al. 2003). Although the "same writing system" is allegedly used across varieties, at a subsegmental level, it is not really the same system. This is not surprising since, in the modular model of writing systems (cf. Section 2.2), language systems were defined as the base modules of writing systems, and in the case of Chinese, a number of mutually unintelligible varieties serve as base modules. Although the same basic shapes are used, and it appears that the same graphemes and subsegmental graphematic components are employed, graphematic relations differ across varieties, and this marks the graphematic modules of Mandarin, Cantonese etc. as fundamentally different, at least with respect to the subsegmental phonological components and, in general, the phonological representation of the morphemes which are represented by graphemes. The only stable constant is semantic components which keep their values across varieties. "The Chinese writing system", if seen in this constrained monolingual view, is, thus, subsegmentally only suited for Mandarin and not for the other Chinese varieties. This raises the important question of how the processing fit (cf. Section 3.3.2) is affected by this. Furthermore, it appears highly likely that the sociocultural fit of the Chinese writing system for other varieties than Mandarin is drastically reduced (cf. Section 3.3.3).

An interesting question concerning the subsegmental level of Chinese that remains is its interaction with the segmental level: while the evaluation of the transparencies of both levels have been mentioned, what about the question whether the components, when they are combined to form a segmental grapheme, transparently contribute to its overall graphematic value? This question is treated by the separate parameter of *compositional transparency* (see below). It is the analog of NM's morphosemantic transparency which evaluated compounds such as *blueberry* as more natural than *cranberry*, since in *blueberry*, the meanings of the components contribute transparently to the overall meaning of the entire word, while in *cranberry*, they do not. Furthermore, within a writing system, this type of transparency represents a form of diagrammaticity: if a specific semantic component always transparently represents the same meaning, and consequently, the complex graphemes that it is a part of are members of one semantic field, then the semantic component establishes paradigmatic endophoric diagrammaticity (cf. Section 3.3.1.2).

The inclusion of the parameter of compositional transparency is paramount since it does not only serve to investigate the structure of complex graphemes in Chinese, but of larger graphematic units in general, which includes graphematic syllables, graphematic words etc. This is also relevant insofar as in NM, words – and not phonemes or morphemes – were proclaimed as "primary signs", which in this case means signs of primary importance and, arguably, signs that are most salient. The parameter of transparency alone as described here exclusively treats the units that can be – following the definition given in Section 2.2.2.1 – identified as the graphemes of a writing system. It evaluates them individually and paradigmatically. As was highlighted in the context of complex tone marking in Thai, no suprasegmental, contextual graphematic operations can be grasped by paradigmatic transparency. Taken alone, the parameter of transparency is not informative: the graphemes of Thai might be individually transparent, but compositionally and positionally, the graphematic module of Thai boasts a high degree of unnaturalness. To disregard these latter dimensions means disregarding crucial factors contributing to the overall linguistic fit of a graphematic module.

Empty spaces which constitute different graphetic units (cf. Section 2.2.1.2) are a central and perceptually salient feature of many writing systems. Spacing is a phenomenon that is captured by a number of parameters, among them *figure—ground* and *transparency*. Empty spaces contribute to transparency in that they are commonly not spread randomly across a text but functionalized to make visible and discernible graphematic units that represent linguistic units. The smallest empty space usually visualizes basic shapes which typically embody graphemes. The next empty space, located at a hierarchically higher level, is also referred to as "interword space" as it is often – but not always – employed to separate graphematic units that correspond with words. Arguably, even if there are other graphetic or graphematic features of words that indicate word boundaries (cf. also Section 2.2.2.4), empty spaces are the visually most salient markers. Thus, I argue, a graphematic module is most natural with respect to spacing if it provides spaces that mark different graphematic units: the smallest empty space demarcates graphemes, the next one graphematic words, etc. At this point, these remarks are only part of a descriptive evaluation of spacing, and it is yet to be determined whether spacing affects processing. Semiotically speaking, spaces allow the distinction of hierarchically and structurally different types of written signs. The descriptively most natural type of spacing would utilize different spaces for each type of sign. Indeed, in many systems in which spaces between graphemes and interword spaces exist, the former are narrower than the latter. The same is not true at a higher level for interword spacing vs. spacing between sentences: with the exception of an (old) culture-specific convention to use two spaces after a sentence-final period, spaces that mark sentences are not visually distinct from spaces that separate words. Arguably, this is at least in part due to the fact that punctuation usually fulfills the task of visibly marking sentences. I propose a subparameter called *unit transparency* which evaluates how spaces make different types of units visible and, thus, transparent. This subparameter is located at the graphetics-graphematics interface since a graphematic function is visualized by a perceptually salient graphetic feature. The visual salience of spacing will be discussed in the context of the parameter of *figure—ground*.

To sum up, following Neef & Balestra (2011), the transparency of a writing system's graphematic module can be evaluated by formulating correspondence rules for all its graphemes. Graphematic relations which are not transparent, i.e. relations in which a basic shape represents more than one linguistic unit, are assigned higher numerical values than relations that are unambiguous. In the end, the values of correspondence rules are added together and divided through the number of basic shapes. The result – from the smallest and most natural gt-value of 1 upwards – indicates a writing system's segmental graphematic transparency. It is segmental insofar as compositional and positional transparency, which are affected by suprasegmental graphematic features, are not accounted for. As shown above, it is possible to transfer this method of calculation to other types of writing systems as well, including morphographic writing systems.

3.3.1.5 Uniformity

The parameter of uniformity focuses on the inverse perspective from transparency: it evaluates how uniformly linguistic units are represented by visual units. As was established in Chapter 2, this perspective was taken by proponents of the referentialist view who took the phoneme inventory of German as a starting point and evaluated how the individual phonemes can be written (cf. Garbe 1985 for a list). In contrast to *graphematic transparency*, which is covered by the eponymous naturalness parameter of transparency, Neef & Balestra (2011) refer to the parameter of uniformity as *orthographic transparency*. This is based on their argument that graphematic transparency affects decoding, i.e. the reading process, whereas orthographic transparency has a bearing on production processes, i.e. writing, and particularly spelling, i.e. writing *correctly*. Accordingly, the fact that they call it *orthographic* transparency is not accidental: in German, for which the concept was described, spellings are not graphematic, but orthographic. The orthographic module is superimposed upon the graphematic module, and even if the orthographic module licenses as correct a spelling that is inside the graphematic solution space, this spelling is still phenomenologically an orthographic spelling rather than a graphematic spelling, since if a writing system has an orthographic module, this module is always phenomenologically primary (cf. Section 2.2.3). The question of whether uniformity as a semiotic parameter indeed influences spelling as assumed here will be discussed in the context of the processing fit (cf. Section 3.3.2.5).

A question that needs to be answered before uniformity can be evaluated is which type of linguistic unit is represented by the written units of a given system. This question is at the heart of writing system typology (cf. Section 2.3.2). Answering it is not entirely trivial since there exists no writing system that is purely of a given type. The mixing of different graphematic principles within a single writing system leads to conflicts of uniformity between different linguistic levels, e.g. phonology and morphology. In German, for example, a certain degree of morphography adds to the uniformity of how morphemes are graphematically represented, but this simultaneously diminishes the uniformity of phoneme representation. For example, the orthographic principle of *morpheme constancy* overrides the transparent representation of final devoicing: therefore, the singular form of <Hunde> ‘dogs’, in which the <d> actually stands for /d/, is written <Hund> ‘dog’ although in the singular, on account of final devoicing, <d> represents /t/. In this case, a lack of transparency leads to a lack of phonographic uniformity: /t/ can be written as <t> in all contexts within a syllable, but, syllable-finally, it is additionally represented by <d>. The fact that the uniformity of the graphemic representation of /t/ is disrupted only in this specific context (syllable-finally) somewhat ameliorates the situation: this becomes evident when other cases such as /f/ are considered, which is represented ambiguously as <f>, <v>, or <ph> independently of the context within a word.

Consequently, writing systems that mix phonography and morphography have two separate values of uniformity: a value for *phonographic uniformity* which assesses how uniformly phonemes are represented, and a value for *morphological uniformity* which evaluates how uniformly morphemes and morphonological alternations are represented. In a language with few phonological processes which alter the phonological representation of morphemes, such as Finnish, phonographic and morphographic uniformity converge and the two principles do not conflict. When the phonological representation of a morpheme is not constant, however, a graphematic module has to choose whether to stay faithful to phonology or morphology. However, this conflict between two types of uniformity is only relevant in writing systems which can, in some way, represent both the phonological and morphological levels. This is most clearly the case for segmental writing systems. When the unit of representation in a writing system is the phoneme, then morphemes which are made up of phonemes can also be represented in writing and the relationship between dominant phonography and optional morphography can always be assessed. If the unit of representation is the morpheme, however, as in morphographic Chinese, phonology is either not represented at all or represented in a very fragmentary and rudimentary way. This goes to show that, following the *strict layer hypothesis*, lower graphematic levels always constitute higher graphematic levels, but if the lowest level in a system is morphographic, representing levels beneath it is optional (cf. Table 5 in Section 2.3.2). The Chinese writing system has subsegmental phonological components, but Handel (2013: 50) notes that there are approximately 800 phonological components for the roughly 400 possible phonological syllables of Modern Standard Mandarin. This means that the syllables are not uniformly represented by phonological components. A subsegmental analysis of uniformity can also be carried out for semantic components: do morphemes which are part of one semantic field uniformly contain the same semantic component? Whereas in Chinese, the conflict between phonography and morphography exists, albeit only to a small degree, in the morphographic part of the Japanese writing system, it does not. In Japanese, morphographic graphemes (*kanji*) do not contain phonographic elements, which means that the only reasonable question which can be investigated here is whether Japanese morphemes are uniformly represented by kanji graphemes.

A feature of writing systems that conflicts with uniformity is positional allography. In Arabic, for example, most consonant phonemes are represented by graphemes with four distinct basic shapes which alternate depending on whether a grapheme occurs in isolation or in sequence; if the grapheme is part of a sequence, its position in the sequence is also of importance. In this situation, consonant phonemes are not uniformly represented by basic shapes. However, as positional allographs are conceptualized as different visual variants of a single grapheme, phonemes are still uniformly represented by abstract graphemes. The question is whether the existence of multiple alternative basic shapes without distinct graphematic status leads to unnaturalness on the parameter of graphematic uniformity. On the parameter of transparency (see above), positional allography is not unnatural since the existence of multiple basic shapes which represent the same linguistic unit only increases the number of units, while the units themselves are transparent. In the case of uniformity, the opposite is the case: one linguistic unit is represented by more than one basic shape. Descriptively, it could be argued that these basic shapes belong to the same grapheme, which would, however, ignore the distinctiveness[300] at the graphetic level. For this reason, I argue that positional allography does reduce uniformity, but it must be assessed in individual system-specific analyses what effect this has on the systems that exhibit positional allography.

To give another example, in Thai, ambiguity is rampant and uniformity is accordingly low. As discussed in the preceding and following sections, the writing system of Thai exhibits graphematic unnaturalness with respect to a whole range of semiotic naturalness parameters. This is evident most clearly for the parameter of uniformity. In a mere paradigmatic analysis which does not take into account positional constraints and context-dependency effects, there are, for example, a whopping seventeen possibilities of graphematically representing /t/. This is partially due to the fact that phonotactically, in syllable-final position, /p, t, k, m, n, ŋ, w, j/ are the only possible phonemes. However, not only the basic shapes that usually represent these phonemes occur in syllable-final positions in written words but almost all basic shapes which represent consonant phonemes. As a result, basic shapes which in other positions represent different phonemes, such as |ศ| which usually represents /s/, are 'reassociated' with one of the phonemes /p, t, k, m, n, ŋ, w, j/ in syllable-final position, in this case /t/.

While there exist systems such as Finnish which almost exhibit biuniqueness, i.e. most natural values on the parameters of transparency as well as uniformity, most writing systems exhibit naturalness on just one of the two parameters. Modern Greek and French, for example, have fairly transparent, but not at all uniform graphematic modules, given the fact that many phonemes in the two languages are not uniformly represented. Transparency and uniformity are not *per se* in conflict, but it is still interesting to note that most writing systems indeed appear to exhibit naturalness on only one of these parameters, with transparency being predominant. This could be another indication that perception is regarded to be more central in the writing systems of the world than production.

3.3.1.6 Compositional transparency

Compositional transparency is a reconceptualization of NM's parameter of morphosemantic transparency. It is concerned with the question whether units of a given graphematic level add up to constitute the value or meaning of units at a higher graphematic level, e.g. whether the value of a grapheme's elementary forms add up to the overall value of a grapheme. Compositional transparency can be evaluated at the subsegmental and segmental levels, but also at higher graphematic levels: do graphemes add up compositionally to equal the phonological representation or meaning of graphematic words?

The most important context for an evaluation of compositional transparency is complex graphemes. Complex graphemes are graphemes which are segmental graphematically, but not graphetically. An example is <ch> in German which consists of two basic shapes but is a single grapheme. From the perspective of compositional transparency, <ch> is unnatural since its representation of the phoneme /x/ does not follow compositionally from its two parts |c|, which

300 Consider, however, the counterargument that positional allographs are, at least in the case of Arabic, visually more similar to one another than they are to basic shapes which are part of different graphematic relations. But consider <σ> and <ς> in Greek, for which this is evidently not the case.

itself is not a grapheme, and <h>.[301] Another important context for compositional transparency is minimal grapheme combinations: in Thai, the vowel grapheme <◌ะ>,[302] which is always dependent on the occurrence of a consonant grapheme, is in a graphematic relationship with the short vowel /a/. However, compositionally, it is part of many grapheme combinations in which it loses its initial value: the complex combination <เ◌ะ> represents the short vowel /e/, and the combination <แ◌ะ> represents the short vowel /ɛ/. They are not complex graphemes since both parts are independent graphemes: <เ◌> represents /eː/, <แ◌> represents /ɛː/. In the combinations <แ◌ะ> and <เ◌ะ>, thus, <ะ> marks that the vowel is short, but does not represent /a/, which it usually does. Compositionally, thus, these complex combinations of vowel graphemes which represent a single vowel phoneme result in unnaturalness on the parameter of compositional transparency.

The non-representation of linguistic units interferes with compositional transparency. In the writing system of Arabic, which is segmental, i.e. represents phonemes, short vowel phonemes are commonly not represented graphematically. A sequence such as <كتب> is, context-independently, decoded as /ktb/. As a triconsonantal root, this bit of phonological representation is arguably the most relevant information to be represented graphematically. However, compositionally, this triconsonantal is ambiguous, as it serves as the basis for many words, among them a slate of words which include only short vowels as vowels and are, thus, written as <كتب> /ktb/: examples are /kutub/ 'books (plural)', /kataba/ 'he wrote', and /kutiba/ 'it was written (masculine)', in which short vowels are not graphematically represented. For the paradigmatic parameters of transparency and uniformity, this absence of short vowels in the graphematic sequence is not of relevance. However, on the syntagmatic axis, compositionality is disturbed because a graphematic representation devoid of short vowel graphemes does not compositionally represent the phonological representations of the words that are written.

Another example of unnaturalness on the linguistic fit caused by compositional opacity concerns the already mentioned complex marking of tone in Thai (cf. Figure 43). It involves three variables: (1) *the type of the syllable*, i.e. whether a syllable is *alive* (ending in a long vowel or in /m, n, ŋ, w, j/) or *dead* (ending in a short vowel or in /p, t, k/), (2) the class of the syllable-initial consonant grapheme (*high, middle, low class*), and (3) the quantity of the vowel (*long, short*) (cf. Smyth 2002: 16). These three variables interact in complex ways to mark five tones: low, mid, high, rising, and falling. The fact that there also exist four tone markers in Thai does only little to reduce the complexity of the situation, as the tone markers themselves are only to some degree transparent and also interact with the other three factors. In combination with consonant graphemes of the high and middle classes, the tone marker for low tone actually marks low tone, but in combination with consonant graphemes from the low class, it marks falling tone. In combination, the three – including tone markers, four – factors transparently represent tone, but individually, these graphematic resources of the Thai writing system are not transparent. Inversely, the situation is even more unnatural, as the five tones are far from being graphematically represented in a uniform way.

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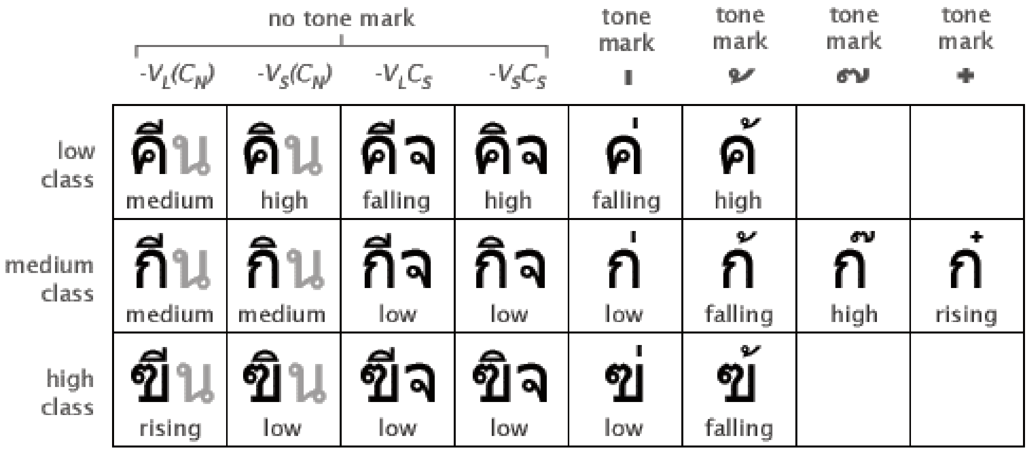
[301] It is a justified question what exactly |c|, if it is not itself a grapheme, should contribute to the overall "meaning" (= signatum) of the complex grapheme if its non-graphematic status means it does not represent a linguistic unit. Consider the trema in German <ä>, <ö>, and <ü>. It is a diacritic, and it changes the graphemes <a>, <o>, and <u> in a systematic way, as it signals fronting of the vowels. It is not itself a grapheme since it is not in a graphematic relation with any linguistic unit. Unlike |c|, it does not occupy its own segmental space and it is not part of the same class of basic shapes as |a, o, u|. It would be imaginable that a graphetically segmental unit such as |c| functions like the trema and modifies the grapheme it combines with in a systematic way.

[302] In the notation of Thai vowel graphemes, the dotted circle |◌| is a placeholder for a given consonant grapheme that the vowel grapheme is dependent on.



	no tone mark				tone mark ่	tone mark ้	tone mark ๊	tone mark ๋
	$-V_L(C_N)$	$-V_S(C_N)$	$-V_LC_S$	$-V_SC_S$				
low class	คีน medium	คิน high	คีจ falling	คิจ high	ค่ falling	ค้ high		
medium class	กีน medium	กิน medium	กีจ low	กิจ low	ก่ low	ก้ falling	ก๊ high	ก๋ rising
high class	ขีน rising	ขิน low	ขีจ low	ขิจ low	ข่ low	ข้ falling		

Figure 43: Complex graphematic representation of tone in Thai, from: https://gtelocalize.com/wp-content/uploads/2018/06/thai1.gif (February 9th, 2019)

A fairly straightforward application of compositional transparency comes in the form of complex graphemes in Chinese. A complex grapheme consisting of a semantic and a phonological component is regarded compositionally transparent if both components are maximally transparent, i.e. the phonological component reliably represents the phonological representation of a morpheme and the semantic component correctly indicates the semantic class membership of the morpheme. Similarly, in complex graphemes that consist of two or more semantic components, natural values of compositional transparency are achieved when all components contribute semantically to a representation of the morpheme's overall meaning.

3.3.1.7 Positional transparency

The syntagmatic parameter of positional transparency, similar to morphotactic transparency, its source parameter in NM (cf. Section 1.3.2), is concerned with the sequence in which elements occur in the signans and the signatum: if, in the signatum, e.g. the phonological representation of a graphematic word, the sequence is /abc/, then it is most natural that the corresponding graphemes are ordered in the same fashion: <abc>. This is not always the case. Since subsegmental components occur 'simultaneously' in graphemes, i.e. share one segmental space, positional transparency is exclusively a polysegmental parameter which assesses the naturalness of larger graphematic units.

One of the most prominent examples of unnaturalness on the parameter of positional transparency is the already mentioned case of misaligned vowels in Thai. Some vowel graphemes completely or partially *precede* consonant graphemes although, in the phonological representation of graphematic words, the corresponding vowel phonemes follow the consonant phonemes: for example, the graphematic word <แปลก> <ɛ:plk> *plek* 'strange' is decoded as /plɛ:k/ although the vowel grapheme <แ◌> precedes the cluster of consonant graphemes <ปล> <pl> in the written form of the word (cf. Winskel 2009: 22). This, from a descriptive point of view, is unnatural, and it is expected to also be unnatural with respect to the processing fit (cf. Section 3.3.2.7).

Usually, in larger contexts such as the graphematic word, it is trivial to determine the position of a grapheme: in <has>, <h> is word-initial, <a> is word-medial and <s> word-final. Logically, in isolation, it is not possible to determine the position of a grapheme. It is in Arabic, however, and it is for Greek <σ> and <ς>. In other words, positional allography (cf. Section 2.2.2.2) adds visual positional information: due to the appearance of the allographic basic shapes, it is clear where in a graphematic word a grapheme is positioned. This, however, does not reveal anything about the position of corresponding phonemes in the phonological representation of a graphematic word, i.e. whether the grapheme and phoneme positions are congruent. Descriptively, the additional positional information provided by positional allography, as is the case in Arabic, is not required. This points to the fact that it is determined and/or has developed productionally (cf. Section 3.2.2) and leads to naturalness conflicts with other parameters (such as uniformity), and, in general, a violation of the principle of economy, since it provides redundant information.

3.3.1.8 Figure—ground

Figure—ground differs from the other parameters. As established in NM, it is a perceptual parameter. It can be viewed from two different perspectives: (1) the perspective of (parts of) the signatum and signans within the sign as well as the relations of these parts with each other, which would conform with the perspective taken by the other parameters above, or (2) the perspective of the entire sign. A more fine-grained analysis distinguishes a total of three levels: the *subgraphemic* level, on which parts of graphemes and their relation to one another are investigated, the *graphemic* level, which studies graphemes and their relation to one another, and the *supragraphemic* level, where larger graphematic units and their relation to one another are analyzed. All three will be discussed below.

The basis of figure—ground, as mentioned, is perceptual, or more specifically, perceptual salience. One element (whether a sign or part of a sign) is perceptually more salient than another element (a sign or part of a sign). The figure is the more salient element, the ground the less salient element.

Subgraphemic level. The first level at which figure—ground relations can be evaluated is *within* individual signs. If visual salience is to be evaluated within a sign, its visual constituent, its basic shape, needs to be segmented into smaller parts. An example of a rather straightforward segmentation which has already been mentioned is Chinese. Here, the different components in a basic shape can be analyzed with respect to figure—ground, and clues are provided top-down by higher levels. If, as it is the case for the majority of basic shapes, they consist of two components, these components are equivalent with respect to figure—ground if the components take up the same amount of segmental space. If basic shapes consist of three, four, or five components, however, the components can usually not be of the same size and thus do not occupy the same amount of the segmental space available for the basic shape.[303] If size is to be taken as a decisive criterion for the evaluation of visual salience, which is contestable,[304] then smaller components serve as grounds and larger components as figures. Figure 44 offers a few examples for two-, three-, and four-component basic shapes, and possibilities for five-component basic shapes are given in Figure 45.

303 Note that there are exceptions, as in a number of three- and four-component basic shapes, the respective components do take up an equal amount of the segmental space. Examples include: <術> *shù* 'technique, art, skill', where the components take up a third of the space each, or <鬆> *sōng* 'loosen, release', in which the four components take up a subsquare of the segmental space, which is divided in the middle horizontally and vertically. Note that these two basic shapes stem from the traditional rather than the simplified Chinese script (cf. Takagi 2014: 88f.).

304 Other features that could also be considered as measures for visual salience and, in turn, figure—ground, are visual complexity of the components or the position of the components within the segmental space, with some positions possibly being more visually salient than others.

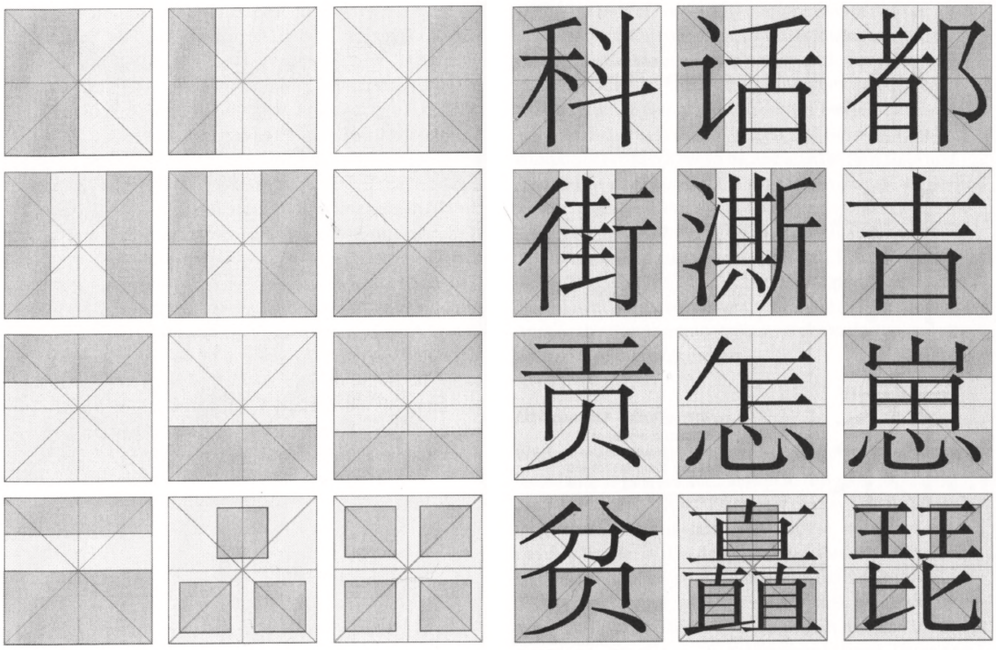


Figure 44: Subdivision of the segmental space in Chinese script, from: Palmer (2015: 32-33)

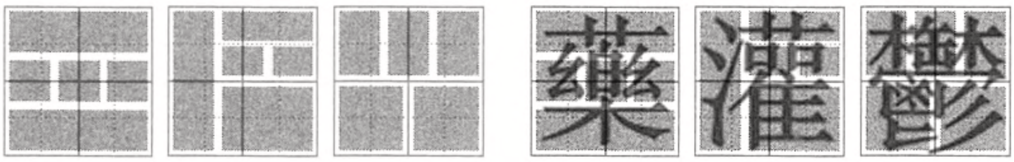


Figure 45: Five-component basic shapes, adapted from: Takagi (2014: 88-89)

Up until this point, figure—ground was only analyzed graphetically as only parts of the signantia of Chinese graphemes were compared with each other. In a next step, it could be analyzed whether this graphetic figure—ground distinction corresponds with a figure—ground distinction in the signatum, i.e. whether, in a grapheme with three semantic components, the graphetically largest component which takes up most of the segmental space contributes most of the meaning to the morpheme represented by the entire grapheme. If this were indeed the case, there would also be a graphematic figure—ground distinction in the grapheme.

Graphemic level. The first and most relevant reflection of the figure—ground distinction at the graphemic level is spacing. Empty spaces, although they are not graphemes themselves, make visible written units of various sizes by setting them apart from or contrasting them with the empty background. On this very page, the empty spaces are white, and these spaces of 'nothingness' bring order to the text both graphetically and graphematically. Along with the described subparameter of *unit transparency* (cf. Section 3.3.1.4), the naturalness value of figure—ground is higher if visual units which are functionalized graphematically are set apart from the background (and each other) by spacing. Note that *unit transparency* can also be achieved by other measures, such as the alternation of scripts in Japanese, which marks word boundaries in the absence of interword spacing. While both are natural with respect to unit transparency, the alternation of different scripts without spaces is not equivalent to the presence of empty spaces on the parameter of figure—ground, as empty spaces are visually more salient. Notably, spacing is one of the most important and well-studied naturalness parameters of the processing fit (cf. Section 3.3.2.8).

One of the first examples that come to mind when the salience of different graphemes is compared is vowel graphemes vs. consonant graphemes in abjads and abugidas. In the abjadic Arabic, the consonant graphemes for short vowels, which are optional, are visually much less salient than their consonant counterparts. This expresses itself in their size, as they are smaller, but also in their position, as they do not occupy their own segmental space but are positioned (almost like graphic clitics) above the consonants. In Thai, typologically an abugida, vowel graphemes are not optional. However, albeit with exceptions, the same visual criteria as in Arabic apply: vowel graphemes are mostly smaller in size and often positioned below or above the consonant grapheme. However, unlike in Arabic, a number of Thai vowel graphemes are as salient as consonant graphemes, as they are equal in size, occupy their own segmental space, and are positioned linearly on the linear space. The fact that there are secondary vowel graphemes which are smaller and vowel graphemes which behave like consonant graphemes leads to a decrease of graphematic naturalness on a range of parameters: diagrammaticity, compositional transparency, and positional transparency, and, of course, figure—ground. Thus, in Arabic and, mostly, Thai, vowel graphemes are the ground to the consonant graphemes, which are the figures. For Arabic, it has been argued that this makes perfect sense: it has been elaborated abundantly in the literature that Arabic makes use of consonantal roots (cf. Ryding 2014: 61-63). By contrast, for Thai, an alternative writing system in which consonant and vowel graphemes are equivalent would also be imaginable, as nothing in the structure of Thai phonology or morphology marks consonants as more salient than vowels. This is also reflected by the fact that Thai is treated as an *alphabet* rather than an abugida in a number of works (cf., for example, Winskel 2009), a classification that neglects that it differs structurally from true alphabets. Other conceptions acknowledge that Thai differs from alphabets structurally, but highlight the fact that in processing, it is treated like an alphabet (cf. Rimzhim, Katz & Fowler 2014).

A similar situation for consonants and vowels can be found for Roman script and most alphabets that employ it, as well as the Greek, Georgian, and Armenian scripts: as discussed in Section 2.2.2.3, basic shapes which are used for consonant graphemes in these writing systems frequently exhibit the feature [+length] while the compact basic shapes used for vowel graphemes do not. Consonant graphemes, thus, are visually more salient in these systems.

The above-mentioned short vowel graphemes of Arabic are independent graphemes and – if they are written, for example in children's books or L2 teaching material – serve as parts of the graphematic word. There exist visually similar units in other writing systems which are, however, only parts of different graphemes and not independent graphemes: so-called *diacritics*. Consider Roman script which has been adopted for a multitude of alphabets and has witnessed a large degree of adaptation and modification. A common strategy of modification is the addition of diacritics to existing basic shapes in order to form new graphemes (cf. Daniels 2006a: 17-20). These diacritics – take the cedilla in <ç>, the háček in <č>, or the tilde in <ñ>, to name only a few – take up only part of the segmental space and are enclitic to the basic shapes they become a part of. They are the ground to the basic shapes, which are their figures. Usually, diacritics not only modify the basic shape they are a part of but simultaneously also alter the graphematic relation in a systematic, diagrammatic way. Note that diacritics, as bound units dependent on other units, unlike vowel graphemes in Arabic and Thai, must be analyzed from a subgraphemic perspective. Graphetically, these two phenomena are equivalent, whereas graphematically, they differ.

So far, only scriptual basic shapes as units of a script used in a given writing system were mentioned. However, other types of basic shapes (cf. Section 2.2.1.2) are also part of writing systems. Take punctuation, for example. It has often been noted that punctuation marks, especially the most frequently used members of the class, the period and the comma, are visually less salient than the graphetic material – mostly scriptual basic shapes – surrounding them. This has to do with their small size and consequently with how much of the segmental space they occupy or fill. They are undeniably grounds to the other types of basic shapes. This lack of visual salience can have a significant effect on how these punctuation marks are processed (cf. Hill & Murray 2000 for an analysis of the comma's effect on processing).

Supragraphemic level. On the highest level of graphematic structure, figure—ground, as described by Dressler (1989; cf. Section 1.4.2) can distinguish between elements of the text such as footnotes, headlines, and the main body of text, categories which are mainly characterized by the functions they fulfill in the larger context, but which are usually also visually distinct. Certain types of graphetic variation, such as bold type, italics, and different colors can also serve as instruments which render something the figure as opposed to a less salient ground. What is necessary for this figure—ground distinction to work, however, is the notion of a graphetic default. A word set in **bold**, for example, can only be perceived as the figure if there is a non-bold word in its proximity. Functionally, I argue that an even larger context is necessary: for bold highlighting to be functionalized at the graphematic level, at least two more words that are not bold are needed. Statistically, in this case, the bold word – which is in this case also the visually more salient one – would be perceived as the variation to the non-bold default (cf. also Meletis 2015: 149f; Spitzmüller 2013: 126). Interestingly, in this case, visual salience in a purely graphetic sense is not necessarily congruent with a graphematic figure—ground distinction: take a paragraph in which every word except for one is printed in bold. Graphematically, "non-bold" will be interpreted as deviance from the default, as the figure to the ground (which is the rest of the bold paragraph) even though it is, technically, at a graphetic level, visually less salient. Conceptually, by contrast, the non-bold word is perceptually more salient as its 'otherness' probably immediately catches the eye of the reader.[305]

3.3.1.9 Other parameters

Other parameters, such as *binarity* and *optimal shape* (and some additional ones, cf. Crocco Galèas 1998), are not separately listed in this section for various reasons. Optimal shape (or "size of the signans", cf. Crocco Galèas 1998: 105) is not included since I argue it cannot be evaluated descriptively. What would be a descriptive criterion to assess the optimal shape of a sign, e.g. a grapheme? This question must be separated carefully from the discussion of the optimal shape of only the visual constituent, the signans of said sign, i.e. the basic shapes of graphemes or the sequences of basic shapes in graphematic words. From this graphetic perspective, the natural optimal shape was already discussed in Section 3.2.2. When, however, the sign as a whole is considered, optimal shape can only be discussed with respect to processing, a context in which it can be analyzed which "shapes" (e.g. graphematic words) are processed more naturally than others, for example because of their length, quantified as the number of graphemes. Additionally, since optimal shape as a parameter is concerned with the sign as a whole rather than the semiotic relationship between the constituents of the sign, it is markedly different from the other parameters.

As for binarity, which, in the context of NM, was formulated to explain the preferred binary structure of compounds such as *credit card* or the binary structure of grammatical relations such as *plural* vs. *singular*, it is not clear how it could be reconceptualized in a graphematic context. A few possible reflections of such a parameter can be identified wherever there are two elements or categories in writing, but each of those reflections appear *ad hoc*: they include the fact that the majority of Chinese graphemes have a binary structure with a semantic and a phonological component, the fact that most lowercase basic shapes of Roman script consist of a binary structure with a hasta and a coda, etc. For a proposal of a Natural Grapholinguistics, it is not necessary to transfer all parameters which were formulated in NM, and binarity is one parameter where this becomes most obvious, since its relevance for a theory of writing is questionable.

The description of parameters in this section (and the next) is by no means exhaustive. While these parameters capture the structure and effect of a number of the most prominent

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[305] However, it is likely that a single bold word in an otherwise non-bold paragraph is detected earlier than a non-bold word in an otherwise bold paragraph. Thus, visual salience and functional salience *do* interact in complex ways.

features of writing and are based on general semiotic principles, it is expected that more parameters could and will be added in future developments of Natural Grapholinguistics.

3.3.2 Processing fit

From the perspective of original Naturalness Theory, and specifically NM, I would argue that the graphematic processing fit is undoubtedly at the core of the naturalness of writing as it captures how writing is processed by users and identifies the features which prove crucial in this context. In NM, what is natural was globally defined as what is easy to process for the human brain, and the core assumption was that the quality of semiotic structures has a direct bearing on the ease or difficulty of processing. In Natural Grapholinguistics, these two aspects – structure and processing – which were originally interpreted as inseparably causally linked are carefully separated into the linguistic fit on the one hand and the processing fit on the other. This separation, I argue, is justified on the grounds that it is one thing to descriptively analyze whether the relationship between a language and the graphematic module of its writing system is transparent, for example, and another thing to investigate, in a subsequent step, whether a transparent graphematic module is processed more easily than a less transparent graphematic module. Intuitively, it appears self-evident that the linguistic fit affects the processing fit, i.e. that the way a "language is written may matter for reading [and writing, D.M.] processes" (Perfetti & Harris 2013: 296), but this is not a sufficient argument against a separation of these two aspects. Furthermore, the influence of one fit on the other is not unidirectional: diachronically, it is claimed – following Dehaene (2009) and others – that the processing fit has strongly shaped the structure of writing. Consequently, the linguistic fit that we can evaluate synchronically is at least in part a result of the suboptimal processing fit of older diachronic stages of a writing system which exhibited less natural linguistic fits. Finally, since writing – much more so than speech – is a cultural technique, the external parameters of the sociocultural fit (cf. Section 3.3.3) are so powerful that in some contexts, they have the potential to override both the linguistic and processing fits.

A number of factors complicate the analysis of the graphematic processing fit. Firstly, there is a lack of data. It would be wrong to claim that there are only little relevant data with respect to the cognitive and psychological processing involved in writing and reading. Quite to the contrary, such data are strikingly abundant, especially in the realm of psychology. However, on the one hand, this abundance makes filtering and identifying the most relevant literature difficult – especially for a linguist. On the other hand, the perspective taken in much of the interdisciplinary research makes its application to the processing fit challenging: the majority of studies interested in reading, writing, and the acquisition of both of these (bundles of) processes focuses on the cognitive skills or abilities needed for reading and writing and not on how these processes are influenced by properties of writing systems (i.e. the linguistic fit). A central notion worth mentioning in this regard is *phonological awareness*. Although there is no consensus on a definition, this concept is the subject of countless studies. Interestingly, while the definition of phonological awareness frequently remains vague, this does not keep scholars from investigating its effects on reading and reading acquisition (and, although not as often, spelling and spelling acquisition). A great number of comparisons of writing systems thus concerns the question of how phonological awareness influences reading acquisition and literacy development in these writing systems. In the process, however, the structural properties of the writing systems themselves are relegated to the background. Research on reading and writing thus largely dismisses the fact that as a cognitive skill, phonological awareness interacts and is crucially dependent on the (semiotic) structure of the writing system that is acquired. However, structural differences are the very basis for the fact that phonological awareness differs in children becoming literate in different writing systems. Inversely, discussions of the properties of writing systems in the linguistic literature often discard psychological and cognitive implications (but see Daniels & Share 2018 for a paradigm shift). Thus, the big challenge inherent in outlining the processing fit is to combine relevant findings from the various grapholinguistic disciplines and to present them from a different perspective.

The following description of the processing fit takes the properties of writing systems – more specifically, the features of their graphematic modules – as a basis and investigates how these properties influence how users process the writing systems. The parameters of the linguistic fit of writing systems described in the previous section serve as a starting point. For each parameter, a number of questions will be addressed: (I) Is the parameter relevant in the processing of writing systems? If so, how? (II) Are the linguistically natural values of the parameter also natural with respect to processing needs, i.e. are the linguistic and processing configurations of the parameter congruent or incongruent? (III) What is the precise interaction of the linguistic and processing fits of the parameter? Does (or has) the processing fit influence(d) the linguistic fit, pointing to the fact that human pressure shapes the development of writing systems?

For one of the parameters described in NM, *optimal shape* (of the whole sign as opposed to only the signans, which was discussed in Section 3.2.2), no naturalness value for the linguistic fit could be determined since what is the most natural or "optimal" shape cannot be decided solely on descriptive terms. It can be determined from the perspective of processing, however. Furthermore, in the discussion of the systematic and processing fits of scripts, the naturalness of the signans of the graphematic sign – the basic shape – was assessed. In the present section, the other component of the sign, the signatum, i.e. the linguistic unit, will be highlighted. An evaluation of the naturalness of individual linguistic units which serve as signata would go too far (and it is the subject of other subbranches of Naturalness Theory such as NP and NM), but what can be reasonably discussed and actually has been the topic of grapholinguistic discussion in the past is *what type* of linguistic unit serves, with respect to the processing fit, as the universally most natural basis of writing systems. A candidate for such a most natural type of signatum that has been brought up is the phonological syllable. This section will critically sketch and evaluate the discussion that led to this assumption.

3.3.2.1 Unit of processing

In the context of the linguistic fit, it was established that what is the most natural unit of representation depends on the type as well as the idiosyncratic features of a given language. However, a most natural unit of representation is descriptively natural, but – as argued above – this does not necessarily have to be congruous with what unit is most natural for processing. Indeed, there is evidence that suggests that even for typologically diverse writing systems, the same linguistic unit might be preferred for processing: the phonological syllable. In this section, I will discuss this assumption as well as other questions which arise in the context of a most natural processing unit.

Indeed, evidence for the processing naturalness of the phonological syllable comes from a striking number of types of evidence relevant in Naturalness Theory (cf. Section 1.3.3). For example, strong indications are given by the history of writing. Daniels (1992) establishes that ancient grammatogenies – of which he mentions Sumerian, Chinese, and Mayan – were, in his terminology, *unsophisticated*, which means that the cultures in which these writing systems were invented had not been literate prior to the invention of these writing systems and had not known the concept of literacy since it either did not exist or they were not aware that it existed in other cultures. This means that these cultures introduced not only writing systems, but writing and literacy *per se*. All of these first inventions of writing created morphosyllabic writing systems. For Chinese, Daniels (1992: 83, 94f.) mentions the possibility of "stimulus diffusion", but for various reasons, he deems it unlikely that the Chinese borrowed the idea of writing from Sumerian. By comparison, modern grammatogenies, i.e. "inventions" or introductions of writing in a given culture, can either be unsophisticated such as ancient grammatogenies or sophisticated, in which a culture borrows the idea of literacy from another culture: the former was the case for the Cherokee or Vai syllabaries, while the latter was the case for Korean Hangul, which is syllabically spaced (see also below), or the Cree syllabary (cf. Section 2.2). The examples provided highlight that both in ancient and modern grammatogenies, the syllable took on a central role. In this context, unsophisticated grammatogenies, in which writing systems were created "from scratch", are most striking. However, for the mentioned ancient grammatogenies, the choice of the syllable as a unit of representation could be logically explained by language-specific properties: in Sumerian, Chinese, and Mayan, words were typically monosyllabic (cf. Daniels 2017: 84). This convergence of syllables and words in one unit, of course, also calls into question whether it was truly the syllable that was central in these creations of writing or whether it was instead the word, arguably also a very salient unit, especially as it is, from the perspective of the double articulation of language, the level of primary articulation. Likely, the word is also the more easily accessible unit as it does not require the same amount of metalinguistic awareness as the secondary level of (syllabic) phonological representation. This possible salience of the word might be one of the reasons that Daniels's "universal" of "(mono)syllabic origins for writing" has been called into question (Klinkenberg & Polis 2018: 59, 93), although neither specific reasons for the doubts nor counterarguments were presented.

In fact, Daniels (2017: 76) cites further evidence for the primacy of the syllable, from fields such as psycholinguistics, literacy instruction, and phonology:

> Psycholinguists find that people not literate in an alphabetic script are unable to manipulate portions of the speech stream at the level of the segment [...]; educational psychologists find that syllabic approaches to teaching children to read can be more successful than approaches requiring them to identify subsyllabic segments [...]; phonologists increasingly work with levels of analysis other than that of the segment or individual sound [...].

The first type of evidence he mentions concerns phonological awareness, specifically the distinction between syllable vs. phoneme awareness. Phonological awareness is, as mentioned, a problematic concept. As there is ample evidence pointing to the special status of the phonological syllable stemming from studies primarily focused on writing rather than phonological awareness, I want to focus on them. This evidence does, nonetheless, often allow drawing conclusions about phonological awareness.

A study which concerns the second type of evidence brought up by Daniels, which could be called 'educational evidence', was conducted by Inkelas et al. (2013). It tested the 'learnability' of writing systems, more specifically whether "the acoustic stability of the speech chunks mapped to symbols is a factor in subjects' ability to learn a novel writing system" (Inkelas et al. 2013: 75). Four types of units of representation were compared: (1) segments, i.e. phonemes, (2) moras, where there is a grapheme for each CV and a grapheme for each consonant coda, (3) onset-rimes, where there are graphemes for each consonant onset and for each VC rime, and (4) demisyllables, where there are graphemes for each CV and VC. Participants had to memorize twenty basic shapes taken from the larger inventory of Cree basic shapes (cf. Figure 46). These basic shapes were graphematically linked to one of the four above-mentioned types of units, with roughly the same number of participants assigned to each type. The authors formulated two conflicting hypotheses: firstly, the *acoustic stability hypothesis*, in which they predict that graphemes which represent acoustically stable speech chunks are learned more accurately, i.e. that learnability decreases in the order demisyllable > mora, onset rime > segment. Secondly, the *alphabetic familiarity hypothesis* in which the authors predict that the participants, native speakers and readers of English, are biased towards an alphabetic, i.e. segmental system.

Figure 46: Subset of Cree basic shapes used in the study, from: Inkelas (2013: 79)

Participants were presented the basic shapes while their graphematic values, i.e. their phonological representations, were played to them as prerecorded sound files. After the learning stage had been completed, a phase of combination training followed in which participants were trained on how to combine the graphemes they had learned to form CVC words. Finally, after the learning and combination training phases, the actual testing commenced. Subjects were asked to read aloud novel CVC words combined from the graphemes they had acquired in the previous stages. For example, they had to read the word with the phonological representation /gik/. This word was graphematically represented in different ways across the four conditions: as three different graphemes <g>, <i>, <k> in the (1) segmental condition, as two graphemes <g> and <ik> in the (2) onset-rime condition, as <gi> and <k> in the (3) mora condition, and as <gi> and <ik> in the (4) demisyllable condition. The results of this task confirm the acoustic stability hypothesis: participants "learn a writing system better if the symbls [sic] are presented to them in speech chunks larger than the individual phone" (Inkelas et al. 2013: 88). While a single study is evidently not conclusive, this interesting experiment provides further evidence for larger phonological units and against the segment as a most natural unit of processing for writing.

Evidence for the importance of the syllable also comes from production. For example, studies have pointed to the importance of syllable boundaries in handwriting. Kandel, Álvarez & Vallée (2006) found that intergrapheme intervals were longer between syllable boundaries than within syllables. In three experimental conditions, the authors tested French and Spanish participants. A striking observation was that the interval between the graphemes in the sequence <gn>, which is always intrasyllabic in French (such as in <consi.gner>) and intersyllabic in Spanish (<consig.nar>), was shorter in French than in Spanish, and not only for monolingual writers of these respective languages, but also for bilingual French-Spanish writers, who systematically produced a shorter interval when writing French (cf. Kandel, Álvarez & Vallée 2006: 26). This also, once again, raises the question of a correspondence between the graphematic syllable and the phonological syllable, as in French, the two are not always congruous: for example, <bar.que> is bisyllabic, whereas its phonological representation /baʁk/ is monosyllabic. When the production of words with incongruous phonological and graphematic syllabifications is compared with the production of words in which the two types of syllables correspond (such as for <bal.con>, /bal.kɔ̃/), it becomes evident that even in phonologically monosyllabic words (as in /baʁk/), a purely graphematic syllable boundary (as in <bar.que>) matters for processing, which is suggested by letter stroke duration and handwriting fluency (cf. Kandel et al. 2009). This also strongly supports the descriptive assumption of an independent graphematic syllable (cf. Section 2.2.2.3), as such a unit appears to affect processing. The graphematic syllable is not only relevant in handwriting, but also in typing. Will, Nottbusch & Weingarten (2006) showed that the inter-keystroke intervals were longer at syllable boundaries, and even longer at syllable boundaries which converged with morpheme boundaries. The authors take their results as evidence that the motor system works with sublexical units instead of holistic words. Strikingly, this is not only the case for hearing writers, but also for deaf writers, whose inter-keystroke intervals were also longer at syllable boundaries (cf. Nottbusch et al. 2005). The authors argue that this delay in deaf writers can obviously not be explained by phonology, which serves as further strong evidence for the independence of a graphematic syllable in processing.

A focus on the concept of phonological awareness and, thus, the phoneme and phonological segmentality, is likely also a reflection of alphabetocentrism. When typologically different writing systems are investigated, a different picture might emerge: recent research on Asian writing systems, for example, has de-emphasized the role of the phoneme in processing in these systems and simultaneously highlighted the relevance of the syllable (cf. Winskel 2014: 174).

Finally, it is interesting to note that even in writing systems which are not syllabic, a level of syllabic representation can take on a structurally relevant role. In the case of the graphematic syllable postulated in German (cf. Section 2.2.2.3), for example, it is the visual feature [+length] of certain basic shapes which embody consonant graphemes which visualizes graphematic syllables (cf. Fuhrhop & Buchmann 2016). This principle is found also in other alphabets such as Greek, Georgian, and Armenian. In Korean, likewise, graphemes are segmental, but arranged in syllable blocks. This makes syllables instead of graphemes visually and graphematically salient. Considering the hypothesis that human pressure shaped the makeup of writing systems, this predominance of syllabic structure in writing could be the result of the syllable's natural processing fit.

3.3.2.2 Iconicity: pictography and diagrammaticity

In NM, iconicity – predominantly its subtype of diagrammatic iconicity – was seen as a natural feature of morphology. In the context of the linguistic fit of the graphematic module, I argued that a different type, imagic iconicity, which, in the case of writing, equals pictography, is to a certain degree unnatural since it is impossible to pictographically represent all the elements of a language which need to be represented in writing. This includes, among others, abstract concepts and function words. The naturalness of iconicity that was postulated in NM is based on the benefits it is claimed to offer for processing, and in particular perception, as signantia which bear a resemblance to the signata they are semiotically related with are assumed to be easier to recognize. This is certainly true for writing as well. However, while pictography might be natural for perception, it requires much more cognitive and physiological effort in production, as a pictographic representation of the objects that linguistic units refer to is an endeavor not unsimilar to drawing (cf. Tversky 1995: 34f.). Once again, production and perception appear to be in conflict. Pictography, and iconicity in general, has to be understood as a matter of degree, of course. A highly pictographic grapheme is expected to be harder to produce than a slightly pictographic grapheme in which the resemblance of the basic shape to the signified object is not as straightforward.

In terms of processing, the benefits of pictography appear to be outweighed by its drawbacks. This corresponds with the plain observation that today, the writing systems of the world exhibit only a small degree of pictography. This is accurate only from a synchronic perspective, as in the history of writing, a number of writing systems, and strikingly, each of the independent inventions of writing – Sumerian, Chinese, and Mayan – exhibited a remarkable degree of pictography. This divergence between ancient and modern writing systems and the associated gradual decrease of pictography suggests that the unnaturalness of pictography dominated over its natural aspects which were the basis for its initial prominence in writing systems.

Recent studies shed a light on the reduction of pictography in the context of cultural evolution. In a study by Garrod et al. (2007), participants were asked to engage in a task which was similar to the game *Pictionary*: one player draws a picture representing a concept and the other player has to recognize what is drawn. Three experiments were carried out on this basis.

(1a) In the first experiment, it was shown that repeated production of a drawing is not sufficient for the drawing to become less pictographic and overall simpler. To the contrary, if a person repeatedly drew the concept (in a total of four blocks) without receiving feedback from anyone until after the drawings had been completed, "the drawings became increasingly complex […] and retained their iconic character" (Garrod et al. 2007: 983). This was the so-called *SD-F condition*, i.e. single director without feedback. (1b) In the *SD+F condition* (single director with feedback), the drawer did receive feedback by a matcher who had not directly observed the production process but was shown the drawing(s) after each of the six blocks and was instructed to give feedback. This allowed the drawer to adapt the drawing in each new block according to the feedback that he had received following the preceding block. (1c) In the third and final condition, the DD+F condition (*double director with feedback*), the two participants alternated roles over six blocks, so after one participant had been the drawer in the first block, he became the matcher in the second block. Like in the SD+F condition, in the DD+F condition, the two participants were separated visually while the drawing was taking place and the matcher was only allowed to give feedback after the drawing had been finished. The feedback, thus, was non-concurrent. (2) In the second experiment, Garrod et al. tested whether the *quality* of feedback has a bearing on the evolution of the degree of pictography of drawings. They did that by comparing the above-described DD+F condition with a similar condition in which, however, the feedback was concurrent and the two participants were standing side by side whenever one of them was drawing (cf. Figure 47 for an example of drawings produced in this condition). In this condition, the matcher in each block could give live feedback while production was taking place. (3) In the third experiment, finally, 'overseers' who had not participated in the first two experiments were given the drawings from the SD+F and DD+F conditions of the first experiment. Two types of overseers were distinguished: early overseers, who were given all of the drawings of a given concept, i.e. all the drawings from blocks 1 to 6, while late overseers were only given the drawings that were produced from blocks 4 to 6. The authors hypothesized that, in general, overseers should perform significantly worse than the matchers who had participated in the original experiment since overseers were not able to interact with the producers of the drawings, and also that late overseers should perform even worse than early overseers since they were not given the full history of the development of a drawing.

The results of these three experiments are striking. In both the SD+F and DD+F (without concurrent feedback) conditions, drawings became simpler (i.e. composed of fewer elements) and less pictographic in the course of the six blocks. The fact that participants in these trials could receive and give interactive feedback after each block evidently served as a form of communicational interaction that allowed *symbols* (as opposed to pictographic *icons*) to arise which bear no visual resemblance to the concepts they represent. Additionally, in the DD+F condition with concurrent feedback, in which both participants alternately drew while the other one was watching, the drawings of the two participants gradually converged visually. What does this mean for the naturalness of pictography in writing?

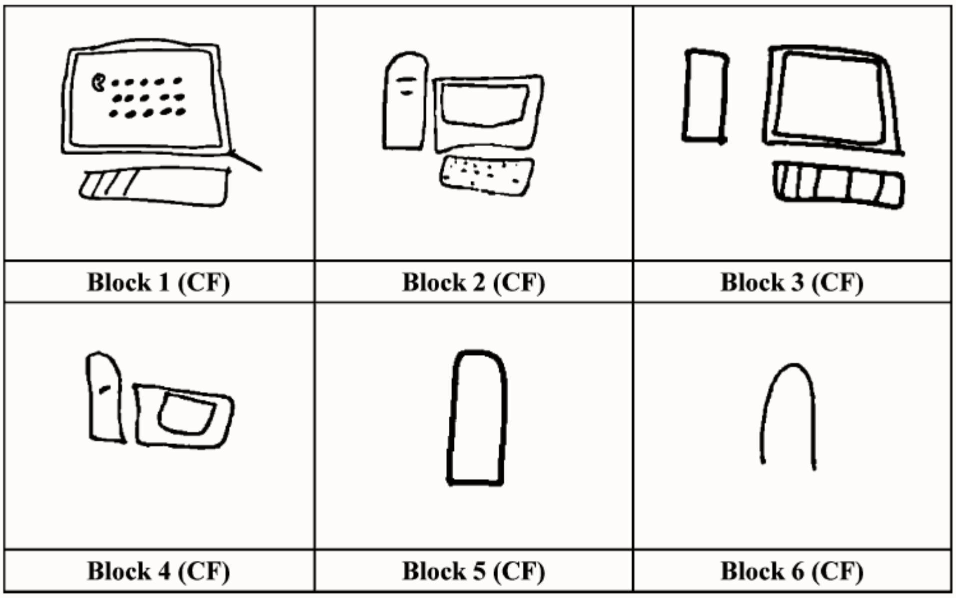

Figure 47: Example for the development of the drawing 'computer monitor' in the DD+F condition with concurrent feedback from experiment (2), from: Garrod et al. (2007: 978)

The initial presence of pictography in a writing system can likely be explained by two factors: (i) creating basic shapes which bear a visual resemblance to what is signified by them requires, at least for basic shapes which graphematically represent concepts referring to concrete objects, arguably less effort than devising abstract and arbitrary basic shapes. Note that this restriction to concrete objects makes pictography relatively easier for production only in morphographic systems, but cf. also Hangul for a phonographic example (cf. Section 3.3.1.2). Secondly, (ii) pictography has some benefits for perception, i.e. recognition and reading. While the initial creation of a writing system and its perception are facilitated by it, pictography becomes a hurdle with respect to the continuous use of a writing system. As I showed in Section 3.2.2, production is largely driven by the force of facilitation. In the context of facilitation, pictography and articulatory simplicity are in conflict, with simplicity winning out in the end. The question is, however: how exactly is pictography diminished? This is precisely where Garrod et al.'s study provides a promising answer: communicational interaction allows the rise of symbolicity and symbolic conventions. Thus, the decrease of pictography is not only driven by the force of facilitation acting upon the production processes of individuals. As the SD-F condition in Experiment 1 showed, without feedback, repeated drawings of the same concept do not become simpler. Furthermore, as the results of Experiment 3 suggested, participants who had not been involved in the initial experiment had noticeable difficulty recognizing which concepts the drawings (especially those produced in later blocks) represented. This is because they had not taken part in the development and therefore did not have knowledge of the graphical history of a given drawing. The decrease of pictography may be conditioned by facilitation, but it is the process of establishing conventions that makes possible the ensuing symbolicity and arbitrariness.

In other words, the production of shapes in a community in which members continuously use them and, crucially, use them to communicate, allows for conventions to be established. Consequently, basic shapes or graphemes[306] which were once pictographic can become abstract and arbitrary, a process referred to as *conventionalization* (cf. Tversky 1995: 35). Of course, the actual continuous use of a writing system in reality differs drastically from the experimental settings in Garrod et al.'s study. However, based on their results, the authors suggest "there may be an alternative grounding mechanism that could operate with repeated and reciprocal use of graphical signs in a community even when there is no direct interaction (e.g., as in the use of a writing system)" (Garrod et al. 2007: 983). By that they imply that in the actual use of a writing system, too, feedback of some kind is offered by other users of the system even when they are not present at the time of production (as was the case in the experimental DD+F condition) or do not give feedback right after production (as in the SD+F condition). When writing is used for communication, which was also its primary function in the pictographic stages of writing systems such as Sumerian, Mayan, and Chinese, the writer writes to be understood, which makes it likely that even in the use of these ancient writing systems there existed some sort of feedback if communication was unsuccessful.

Ultimately, it cannot be stated whether pictography, i.e. imagic iconicity in writing, is an unnatural or natural feature of writing, as this assessment depends on the perspective taken. An interesting idea that Garrod et al. (2007: 963) formulate is that "during the evolution from iconic to symbolic graphical representation, structural complexity migrates from the sign to memory representations in sign users". This emphasizes the tradeoff between physiology and cognition. When shapes become easier to produce (and, on a merely physiological level, to perceive), they require more cognitive effort to be recognized and categorized since the relations between the visual and the linguistic become increasingly arbitrary. However, as Tamariz et al. (2018: 347) note, "[g]raphical iconicity is costly in terms of time and effort – the details need to be drawn accurately when the conventions are being established, but once the conventions are entrenched, simplified forms work just as well". This implies that there might be more cognitive effort involved in acquiring and memorizing arbitrary graphemes, but once they are mastered, they are not particularly less suited to processing than pictographic graphemes.

306 Pictographic basic shapes and pictographic graphemes are not equal. A shape itself, independently of what it might linguistically represent, can be iconic semasiographically, when it resembles a thing or concept directly. A grapheme, on the other hand, is pictographic only when the shape is in an iconic relationship with the signatum, i.e. the linguistic unit that is part of a grapheme. The two types of iconicity can coincide such as in the Chinese character for *tree*, where the shape visually resembles a tree and represents the morpheme which has as its signatum 'tree'.

A second study worth mentioning in this context is Caldwell & Smith (2012). While Garrod et al. (2007) investigated *dyads*, i.e. groups of two participants each, Caldwell & Smith observed the behavior of so-called *replacement microsocieties*. They chose to do so because they argue that studies such as Garrod et al. (2007) "imply that the process of simplification may be restricted to repeated horizontal interactions between users who are aware of the iconic roots of the signs they use, and who have played an active role in negotiating the simplified form". This, however, would mean that "the role of cultural transmission may in fact be severely limited in explaining the emergence of symbols" (Caldwell & Smith 2012: 2). To test whether this is indeed true, instead of dyads, the authors tested multiple chains of each ten people. However, in each of the seven rounds of the experiment, only four of the ten people participated. These four participants formed a so-called *microsociety* in which one person was the drawer and three persons were matchers. After each round, the drawer, who was simultaneously the most experienced member of the group, was replaced by a new, 'naïve' member. In round 1, for example, P1 was the drawer, and P2, P3, and P4 were matchers. For round 2, P1 was replaced by P5. P2 became the new drawer, while P3, P4, and the newly added P5 were matchers. After that, P2 was replaced by P6 and so on (cf. Table 10). The first six rounds represented *transmission phases* in which one of the matchers responded publicly on behalf of all the matchers with what they believed a drawing represented. The seventh and final round, in which P10 was added as the last member of the chain, constituted the test round in which all matchers (P8, P9, P10) gave their respective responses privately on a response sheet. Additionally, matchers in round 7 were presented not only the drawings that had been completed by members of their own chain but also drawings by members of other chains.

Table 10: Composition of the test group over rounds of the experiment, from: Caldwell & Smith (2012: 3)

Round number	Drawer	Matchers
1	P1	P2, P3, P4
2	P2	P3, P4, P5
3	P3	P4, P5, P6
4	P4	P5, P6, P7
5	P5	P6, P7, P8
6	P6	P7, P8, P9
7	P7	P8, P9, P10

The clearest result of the study, as Caldwell & Smith (2012: 7) state, is that "arbitrary and contrasting conventions were established within microsocieties, and [...] these were transmitted to naïve newcomers to the group who themselves had played no part in negotiating the usage of that particular sign". They report that by round 3, trial durations had decreased significantly when compared with durations of the first two rounds, which – together with other factors – indicates that by round 3, drawings had lost their pictographic character and had become arbitrary. One of the most striking findings concerns the advantage that experienced matchers, i.e. matchers who had been participating for at least two rounds, appeared to have in recognizing drawings from their own microsociety. The authors argue that this advantage did not stem from cues provided by the interactive context, such as drawers' movements during production which could be witnessed by matchers, since these cues were also available to naïve newcomers, who, however, showed no advantage in recognition. Instead, the authors argue the experienced matchers' recognitional advantage was due to a drawing's similarity to drawings produced previously, i.e. in earlier rounds. In the terms introduced in Section 3.3.1.2, *endophoric iconicity*, or also *relational iconicity*, had supplanted exophoric iconicity, since what appeared to be relevant at this stage was the "resemblance between sign and sign, not between sign and object" (Garrod et al. 2007: 965). Accordingly, drawers who had been matchers in previous rounds did not attempt to represent the initial meaning pictographically, but to convey visual similarity to previous drawings by means of endophoric iconicity.

Caldwell & Smith (2012) show even more clearly than Garrod et al. (2007) how pictography can and is likely to decrease in writing systems due to *cultural transmission* and *cultural evolution* (see also the studies by Fay et al. 2010, Tamariz et al. 2018, and the review in Tamariz 2017). As these terms suggest, the cause for the decrease of pictography is fundamentally sociocultural. However, it is mentioned here instead of in the context of the sociocultural fit of writing systems (Section 3.3.3) since I argue that it is still facilitation of production which renders pictography ultimately unnatural for production, and in turn, continuous use. The fundamental sociocultural dimension as outlined above 'only' makes possible that this facilitation occurs in an 'orderly' fashion. Conventionalization is, possibly, a natural reaction to facilitation which ensures that communication remains possible. If everyone in a community were to simplify shapes however they wanted to, vast and uncontrolled variation would render communication cumbersome, inefficient or even impossible. The decrease of pictography, initiated by its articulatory unnaturalness, is accompanied by a conventionalization of shapes that become increasingly arbitrary. Facilitation is a matter of processing (and secondarily, communication, since units which are easier to produce are arguably also easier to use in communication), while conventionalization is a sociocultural matter.

While what has been discussed so far concerns imagic iconicity, nothing has been said about the effects of diagrammatic iconicity on processing. This is due to the fact that empirical evidence on the relevance of diagrammaticity is sparse. For language in general, diagrammaticity is claimed to facilitate the acquisition of categories as it allows exploitation of "the regularities in the mapping between representational spaces in different modalities" in early language development (cf. Dingemanse et al. 2015: 609). Children's productions during early literacy acquisition exhibit features which could be interpreted as diagrammaticity: Pontecorvo (1985) describes an Italian 5-year-old who wrote both Italian words for *cane* 'dog' and *cagnolino* 'little dog' using three graphemes, respectively, but the graphemes' basic shapes were bigger when the intended word was 'dog' than when it was 'little dog'. Levin & Korat (1993) mention Israeli children aged 4 to 5 who used more units when they wanted to write 'forest' than when they wanted to produce 'tree', which is highly reminiscent of the diagrammaticity of the Chinese graphemes <木> 'tree' and <森> 'woods' (cf. Section 3.3.1.2). Furthermore, in a transmission experiment similar to the ones described above, Kirby, Cornish & Smith (2008) found that an artificial language which was transmitted culturally maximized its own transmissibility by becoming more structured, i.e. increasing its degree of diagrammaticity.

Findings of this nature are scattered throughout the literature. Their random collection here does the assumed relevance of the parameter of diagrammaticity for processing no justice. Accordingly, a more systematic and elaborate analysis of the interaction between diagrammaticity and processing is in order for further developments of a Natural Graphematics, which will undoubtedly also require generating more empirical evidence.

3.3.2.3 Indexicality

As established in the context of the linguistic fit, the parameter of graphematic indexicality works best at higher levels of graphematic organization, mainly the textual level. In this reading, indexicality is rather unique among the graphematic naturalness parameters as it serves an intra-textual evaluation of naturalness rather than an intra- or even inter-systemic evaluation of different writing systems and their resources. This means that on the parameter of indexicality, writing systems which offer the same types of textual resources are equal, and it is specific texts realized in those writing systems – even texts realized in one and the same writing system – which are not equal, as their structural makeup can be more or less natural with respect to indexicality. The central factor for the evaluation of the naturalness of indexicality is heavily influenced by *gestalt theory* and was already highlighted as relevant in Natural Textlinguistics (cf. Section 1.4.2): *spatial contiguity*.

In their study, Holsanova, Holmberg & Holmqvist (2009) investigated the effect of spatial contiguity on processing. They compared how readers process different types of complex layouts by analyzing their eye movements. Studies like this are relevant given the fact that most texts which are consumed by readers nowadays are structurally complex: consider the typical layout of newspapers. Not only different levels of written textual organization – headlines, captions, quotes, the main body of text – are integral parts of a complex newspaper layout, but also other types of semiotic material such as photos, figures, tables, diagrams, etc. It appears obvious that different arrangements of these distinct types of elements affect the reading process in different ways, and this is precisely one of the aspects captured by the parameter of indexicality.

Broadly speaking, with respect to indexicality, there are two types of complex texts. First, there are texts that include no explicit connections between text and other elements such as tables or figures. In the reading of such texts, "[w]hen the eyes reach a certain point in the text, it is the reader who has to discover the referential links between the text and the graphics" (Holsanova, Holmberg & Holmqvist 2009: 1216). This may be cognitively more challenging than reading the other type of texts in which these links are explicitly suggested by features of the text. These features help guide the reader, and they have been studied in the context of the *cognitive theory of multimedia learning* (cf. Mayer 2005). One of these features which highlight indexical relations between textual and non-textual material is captured by the *spatial contiguity principle*: placing elements such as text and an associated figure in close physical proximity to one another highlights their relationship, which can render the reading process cognitively easier. Another feature is captured by the *signaling principle*: cues which highlight the organization of a complex text aid reading. One of the cognitive processes that are influenced by the design of textual layouts is *cognitive load*. According to *cognitive load theory* (cf. Sweller, van Merrienboer & Paas 1998), which, notably, focuses on processes of *learning* and not specifically on reading processes, "instructional materials should be designed to prime the integration of pictorial and verbal representations into a coherent mental representation" (Holsanova, Holmberg & Holmqvist 2009: 1216). Three subtypes of cognitive load make up the total cognitive load: (1) *intrinsic cognitive load* is determined by the complexity of the material and by the competence of the learner, (2) *extrinsic cognitive load* is constituted by the design of the learning material – which is where indexicality is relevant –, and (3) *germane cognitive load* is the type of cognitive load that is necessary for a learner to comprehend the learning material. Studies investigating the effects of indexicality on processing focus on extrinsic cognitive load. The main hypothesis is that explicit indexical cues in the layout of a text can lessen extrinsic cognitive load and, in the process, support the other two types of cognitive load by freeing up resources for them.

In their experiment, Holsanova, Holmberg & Holmqvist (2009) tested whether a textual layout corresponding to the *dual scripting principle* aids the reading process. More specifically, they investigated whether it is beneficial for so-called *attentional guidance*. The dual scripting principle combines the features of spatial contiguity and signaling. The former contributes to an optimal navigation through the text and the latter aids semantic integration, i.e. comprehension, through a conceptual organization of the text. Both of these principles concern the parameter of indexicality. To test the effect of the dual scripting principle, the authors compared readers' eye movements in the reading of infographics which were presented in different layouts. Infographics represent a special multimodal text genre which combines illustrations with text and graphic cues such as arrows to describe and explain certain complex phenomena. The two layouts that were presented were (a) a *separated layout*, in which illustrations and text were located far from one another, which was compared with (b) an *integrated layout*, in which the elements were spatially contiguous. A second comparison juxtaposed (c) a *radial layout*, in which illustrations and texts were not necessarily far apart but arranged in a non-serial way that allowed for multiple reading entry points and reading paths, with (d) a *serial layout* which was spatially pre-structured and (more or less strongly) suggested a reading path. Not surprisingly, as suggested by their eye movements, the integrated and serial layouts were processed more efficiently by readers.

The findings were interpreted, among other things, on the basis of the quantity of *integrative saccades*, defined as "transitions between semantically related pieces of verbal and pictorial information, indicating the process of readers' construction of referential connections between text and illustration" (Holsanova, Holmberg & Holmqvist 2009: 1222; for a more detailed description of eye movements, cf. Section 3.3.2.8). In the integrated and serial layouts, the mean proportion of integrative saccades was significantly higher than in the separated and radial layouts. Additionally, in the condition radial vs. serial, readers seemed to follow the reading path suggested by the serial layout and spent almost twice as much time reading it, whereas – as the authors interpreted – readers quickly became disinterested in the infographic when presented in the radial layout since they "have several decisions to make – to choose the entry point, to decide about the reading path, to find relevant pieces of information, to create a connection between them and to integrated [sic] them mentally" (Holsanova, Holmberg & Holmqvist 2009: 1224).

A single study does not suffice to proclaim the most natural configurations of the parameter of indexicality for processing. It does, however, point to the relevance of indexical phenomena. The fact that indexicality, as treated here, is a universal feature of text design which is independent of the writing system and script in which said design is materialized means that this parameter is also not useful in comparisons of different writing systems or scripts, which also warrants its brief treatment in this chapter. In fact, I argue that indexicality, as outlined above, is, although it is central for the written modality of language, a parameter that fits better into the paradigm of Natural Textlinguistics in which it has already been described (cf. Dressler 1989: 23-35). Natural Textlinguistics focuses on the naturalness of (mostly written) texts and textual devices predominantly from an intra-textual perspective, which is exactly the scope of the effects of indexicality.

3.3.2.4 Transparency

The question if and how transparency affects processing is central, since transparency is a parameter of the linguistic fit of writing systems on which even writing systems *within* well-defined typological categories such as the alphabet vary remarkably. Consider vast differences between the structural make-up of English vs. Finnish, for example. For this reason, parameters such as transparency can provide a basis for more fine-grained cross-grapholinguistic comparisons that go beyond established typological classifications. In this section, the question of how transparency affects processing is discussed. The focus is on perception since transparency, by definition the property of a written unit to represent consistently only a single linguistic unit, plays a more crucial role in decoding, whereas the inverse parameter of uniformity (see below) takes center stage in production.

No discussion of transparency can do without mentioning the so-called *Orthographic Depth Hypothesis* (ODH). This well-known hypothesis postulates that more transparent writing systems should be easier to read since they allow more direct access to phonology (cf. Katz & Frost 1992). This connection is based on the assumption that reading, or more specifically, those word-recognition processes which rely on phonology, are facilitated by more transparent semiotic relations between basic shapes and phonemes. As this characterization implies, the ODH is concerned with phonographic transparency and in this form can only capture effects pertaining to the processing of phonographic writing systems or phonographic elements in writing systems (cf. Daniels & Share 2018). The ODH would predict, for example, that reading morphographic kanji graphemes in Japanese is harder than reading the syllabic kana graphemes since kanji allow no access to the morphemes' phonological representations, which, however, are central for the ODH. This one-dimensional view of phonographic transparency obviously disregards other types of transparency such as morphographic transparency. However, if a morphographic grapheme transparently represents a morpheme, this might also have beneficial effects for processing even when no information in the grapheme is available for the phonological route of decoding. The ODH undeniably places emphasis on phonographic aspects of the reading process, although in its weak form, it acknowledges that phonology is not the only relevant variable in reading (cf. Katz & Frost 1992: 72). Although morphography does not only play a role in morphographic writing systems but, as a secondary principle, also in phonographic systems (cf. Schmidt 2018 for German), the morphological reading of transparency has not gained currency in reading research. Thus, there is a lack of studies on the question of how the (in)transparent representation of morphemes or morphological information affects processing, even for morphographic writing systems (see below).

There is an abundance of studies which provide evidence for the assumption that phonographic transparency is a relevant parameter for processing. Specifically, phonographic transparency is claimed to be beneficial for reading. Thus, phonographically transparent writing systems are acquired faster (cf. Seymour, Aro & Erskine 2003) and are less error-prone than non-transparent systems (cf. Cossu et al. 1995). Furthermore, they are read aloud more quickly by children than non-transparent writing systems, which is interpreted as an indication for better literacy development as a whole (cf. Ellis et al. 2004). Additionally, in conceptions which assume a reciprocal relationship between phonological awareness and reading, phonographic transparency is claimed to benefit the development of phonological awareness, as "the one-to-one mapping between letters and sounds in a transparent orthography promotes access to phonemes, thus boosting basic phonological-awareness skills and helping to trigger the development of phoneme-sized representations" (Ziegler et al. 2010: 556; cf. also Castles & Coltheart 2004).

The literature on the effects of phonographic transparency (in the literature often referred to as *orthographic transparency*[307]) is massive, and it is not my goal to provide a comprehensive picture here. The evidence cited above strongly suggests that descriptively assessed transparency in the graphematic module leads not only to a natural linguistic fit but also to a natural processing fit of writing systems. This, in itself, is not a groundbreaking conclusion, but it leaves open the central question of the conflict between phonographic and morphographic transparency. Both can be simultaneously attained only in phonologically simple languages such as Serbian and Croatian. In cases in which these two types of transparencies converge, "morphologically related words have a common phonologically invariant core" (cf. Katz & Frost 1992: 70). Usually, however, there is a tradeoff between them, and phonographically transparent systems are morphographically intransparent or morphographically transparent systems are phonographically intransparent. In this context, a frequently made observation is that beginning readers rely on phonographic transparency while skilled readers rely more on morphographic transparency (cf. Daniels & Share 2018: 108). In German, for example, morphography is explicitly regarded as a graphematic aid for reading (Fuhrhop & Schreiber 2016). The beneficial effect of morphographically transparent consonant doubling (such as <nn> as in <können> 'can') on processing, for example, has been shown by Bredel, Noack & Plag (2013). The transition from decoding phonologically to decoding morphologically occurs not only in phonographic systems but also in morphographic systems: children learning to read Chinese first rely more on the phonological components of graphemes when reading but gradually come to rely more on cues of meaning provided by the semantic components (cf. Tong, Tong & McBride 2017). Ontogeny is reflected in phylogeny, as there is a trend for writing systems to change from being phonographically transparent to becoming lexically distinctive, i.e. morphographically transparent, which Sampson (2018) demonstrates for English. Note, again, that in phonologically simple systems, these two types of transparency are not in conflict.

In sum, it is clear that transparency is a central parameter of graphematic processing naturalness as it makes perceptual decoding processes not only possible but more efficient.

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307 Once again, the question of whether this type of transparency is graphematic or instead 'orthographic', as it has been called in the literature, is justified. When reading, readers of most writing systems are in fact confronted with its orthography. However, since transparency is (unlike, for example, compositional transparency) a paradigmatic parameter (cf. Section 3.3.1), it is concerned with segmental relations between basic shapes and linguistic units, and these, I argue, are not regulated by the orthographic module, which regulates sequences of graphemes, e.g. within written words, instead. Whether /s/ is spelled <s> or <ß> in German, for example, cannot be decided segmentally, but only syntagmatically within a larger context. In such contexts, both spellings are in the graphematic solution space, but only one is orthographically correct.

Which subtype of transparency is more central, however, i.e. which linguistic level is transparently represented by the graphematic module, is a question that must be assessed individually for each writing system, independently of its type. It is fundamentally a question of the linguistic fit, as the structure of a language mandates which type of transparency is more suitable. Given the above-mentioned findings on phonographic transparency, transparency in general is expected to have direct repercussions for processing. More studies on how users benefit from morphographic transparency in phonographic systems and phonographic transparency in morphographic systems are needed, however.

3.3.2.5 Uniformity

Uniformity is the inverse parameter to transparency. It captures whether linguistic units are represented uniformly by written units. If a linguistic unit is only represented by a single written unit, the semiotic relationship between them is uniform. Because this parameter implies the direction *language* → *writing*, it is expected to affect processing not through the mediation of reading processes, but spelling processes. Note that writing systems whose graphematic modules exhibit a high degree of transparency can but need not necessarily be uniform, and vice versa. In transparent but non-uniform writing systems, spelling can be more difficult than reading (cf. Bosman & Van Orden 1997) since writers must choose between the often many possibilities of writing a given linguistic unit that are offered inside the graphematic solution space (cf. Geva, Wade-Woolley & Shany 1993: 384). Consequently, spelling acquisition can lag behind reading acquisition, as it is "a challenge in spelling [...] to specify orthographic units that may be irrelevant for reading" (Gingras & Sénéchal 2019: 37). This has been shown for a number of systems, including Thai (cf. Winskel 2014), German (cf. Wimmer & Mayringer 2002), French (cf. Sprenger-Charolles, Siegel & Bonnet 1998), Hebrew (cf. Geva, Wade-Woolley & Shany 1993), Brazilian Portuguese (cf. Pinheiro 1995), and Persian (cf. Rahbari, Sénéchal & Arab-Moghaddam 2007). Non-uniform graphematic relations between linguistic units – in all of the above-mentioned systems, these are phonemes – and basic shapes lead to difficulties in production.

3.3.2.6 Compositional transparency

Compositional transparency, as characterized in Section 3.3.1.6, determines whether the combined values of parts equal the value of the whole, e.g. whether adding up the values of subsegmental graphematic components results in the value of the resulting grapheme or, at a higher level, whether the combined values of graphemes equal the value of the graphematic sequence, be it a graphematic syllable, graphematic word, etc. Aside from compositional transparency itself, there are at least three subtypes of compositional intransparency: (1) *graphematic excess*, when the graphematic string provides more information than would be necessary for the representation of the corresponding linguistic unit, (2) *graphematic underspecification*, when not all parts of the signatum are represented in the signans, and (3) *graphematic mismatch*, when adding up the graphematic values of the parts does not yield the value of the graphematic whole.

As mentioned before, the graphematic representation of vowel phonemes in Thai can be complex. Some vowel phonemes are represented by one basic shape, others by a combination of two or more basic shapes. This is complicated by the fact that the parts which contribute to the complex marking of vowels are themselves independent graphemes with distinct values. Take <◌ะ>, which is the grapheme representing /a/, and <เ◌>, which represents /eː/. The corresponding short vowel phoneme /e/ is represented graphematically by the complex sequence <เ◌ะ>, which is a graphematic mismatch. The presence of <เ◌> in this graphematic sequence signals that the sequence is diagrammatically related to the corresponding long vowel /eː/, whereas <◌ะ> does not have its usual graphematic value of /a/. Instead, <◌ะ> marks vowel quantity, and it is used in this function also in the complex graphematic representation of other vowels. Consequently, on the paradigmatic parameter of transparency, <◌ะ> is not transparent, since it represents a vowel phoneme and simultaneously marks vowels as short. This also diminishes the compositional transparency of the complex vowel sequences that it partakes in. As for processing, a study by Winskel (2010: 26) shows that the spelling of complex vowels is more error-prone and acquired later by children. She attributes this to 'memory load' which she claims is higher for the spelling of complex vowels than of short vowels.

Arabic provides an example in which compositional transparency affects the processing of higher graphematic levels. In Arabic, not all vowels are represented graphematically, as short vowel phonemes typically remain unrepresented. This means that usually, in Arabic, the compositional value of a graphematic word, e.g. <CCC>, does not correspond with its phonological representation, e.g. /CVCVCV/. This is a type of graphematic underspecification. However, short vowels *can* be written, and experiments have tested whether representing all phonemes, i.e. aiming for complete naturalness on the descriptive parameter on compositional transparency, is more natural from a processing perspective. Existing studies have yielded inconclusive results with respect to this question. In an investigation of accuracy and fluency of reading aloud, Asadi (2017) tested 1516 Arabic-reading children from first to sixth grades. The results indicate that unvowelized Arabic is read more accurately and fluently in all grades except for the first and second grades, for which reading accuracies in the vowelized and unvowelized conditions are similar. In general, reading unvowelized Arabic appears to be more natural than reading vowelized Arabic (cf. Saiegh-Haddad & Schiff 2016; Taha 2016). There are at least two possible explanations for these findings: firstly, vowelization makes the writing system more complex graphetically, as it increases the visual material that needs to be processed and contributes to "a visual load that may interrupt fluency" (Asadi 2017: 139). Secondly, a possible benefit of vowelization for reading is a function of grade level (cf. Shany, Bar-On & Katzir 2012 for similar results for Hebrew). This has several reasons, one of which is that at the beginning of literacy instruction, children are taught the vowelized version of the writing system, with the unvowelized variant being introduced in the third and fourth grades (cf. Asadi 2017: 138). A second reason is that beginning readers appear to be more reliant on transparent phonographic information since the 'orthographic lexicon' is not yet developed and direct access to meaning through reading is not as fast as through phonological access (cf. Asadi 2017: 144; Taha 2016: 139f.). This would be consistent with the *Orthographic Depth Hypothesis* (see above).

However, as implied above, the findings of a number of studies contradict the assumption that full phonographic compositional transparency is beneficial. This, as already mentioned above, is explained with increased visual complexity (cf. Ibrahim 2013; Taha 2016; Asadi 2017). By contrast, other studies (e.g. Abu Rabia 1998, 2001) have pointed to a facilitating effect of vowelization on reading accuracy and comprehension. Additionally, there is evidence that vowelization helps disambiguation of heterophonic homographs, i.e. graphematic words which are written the same way in their unvowelized versions but have different phonological representations. By contrast, vowelization has no effect on unambiguous words (cf. Maroun & Hanley 2017).

The third type of compositional intransparency, graphematic excess, is exhibited by graphematic words that include 'silent' graphemes, i.e. graphemes "that do not serve a phonological function" (Gingras & Sénéchal 2019: 37). 'Silent', of course, is a phonocentric term, as silent graphemes have been described only for phonographic writing systems. Graphematic excess is not restricted to phonography, however. In graphematic units of morphographic systems, too, graphematic information can be present that does not represent any linguistic, in this case morphological, information. A recent study of silent graphemes in French showed that more cognitive effort is required to process them than graphemes that are not silent. A possible explanation could be that "nonphonological letters are more likely to be omitted from orthographic representations given their lack of phonological value" (Gingras & Sénéchal 2019: 44f.). Descriptively, this can be captured by the fact that paradigmatically, a silent grapheme is not associated with a segmental signatum the way graphemes that represent phonemes are. As such, it does not contribute phonographically to the phonological representation of a graphematic word. Note, however, that in some cases, while 'silent' graphemes are non-phonological, they have other values, such as the plural morpheme <-s> in <amis> 'friends'. The grapheme might not be salient phonologically, but it is salient morphologically. However, it is acquired much later than phonographic graphemes in French (cf. Totereau, Thevenin & Fayol 1997).

3.3.2.7 Positional transparency

Ever since 2003, a text referring to (fictitious, cf. Velan & Frost 2007: 913) research conducted at Cambridge University has circled the internet. In it, many words are characterized by the fact that their internal graphemes are transposed while the first and final graphemes are kept intact. It reads:

> Aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are, the olny iprmoetnt tihng is taht the frist and lsat ltteer be at the rghit pclae. The rset can be a toatl mses and you can sitll raed it wouthit porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe.[308]

The ongoing (mostly public) fascination for this text stems from the fact that although the graphemes are 'jumbled', the text, as it itself points out, remains readable and understandable. This effect that – based on the alleged research referred to in the text – has been termed *Cambridge University effect* has subsequently attracted the attention of the reading research community. Most strikingly, it poses severe problems for models of word recognition such as the *IA model* (McClelland & Rumelhart 1981) and the *dual-route cascaded model* (Coltheart et al. 2001) which are position-specific, i.e. code grapheme positions explicitly and absolutely (cf. Section 3.2.2). The awareness for the shortcomings of these models spawned a number of models of reading (particularly word recognition) which allow for some flexibility of grapheme positioning. These newer models include the *SERIOL model* (cf. Whitney 2001), the *SOLAR model* (cf. Davis 2010), the *open bigram model* (cf. Grainger & Van Heuven 2004), and the *overlap model* (Gomez, Ratcliff & Perea 2008).

With respect to the linguistic fit, positional transparency was defined as the alignment of corresponding elements in the signans and the signatum, i.e. that a series of graphemes <abc> corresponds to a sequence of phonemes /abc/. Whether the parameter as defined in this manner is relevant also for processing can be best evaluated by investigating how positional mismatches are processed. These mismatches are not just the result of graphematically illegal errors, but, in some systems, idiosyncratic features. A prominent example for this is Thai, which exhibits so-called *misaligned vowels* which were already characterized in Section 3.3.1.7. Winskel (2009) examined how these misaligned vowel graphemes are processed by Thai adults and children. In the course of four reading and spelling experiments, she found that there is no significant processing cost associated with misaligned vowels that operate *within* syllables (she calls them Type 1), whereas misaligned vowels that operate across syllables (Type 2) are a source of many errors, especially for children in the process of literacy acquisition.

An example for a Type 1 word is เพลง <ephlŋ> /phleŋ/ 'song', an example for Type 2 แมลง <ɛ:m(a)lŋ> /m(a)lɛ:ŋ/ 'insect'. In the Type 1 word, the vowel <เ> = <e> is written initially although in the equivalent phonological representation, it follows the consonant cluster <พล> = <pl>. However, as the word is monosyllabic, the scope of this misalignment is intrasyllabic. In the Type 2 word, the vowel <แ> = <ɛ:> is written initially, i.e. at the beginning of the first of two syllables, although it is the medial vowel of the second syllable. The first syllable is <ม> = <m(a)>, where (a) indicates an implicit vowel. The misaligned vowel <ɛ:> fits into the second syllable, <ลง> = <lŋ>. These Type 2 words, in which misaligned vowels are positioned across syllable boundaries, produced the greatest processing cost for Winskel's participants. This pro-

[308] This is taken from https://www.mrc-cbu.cam.ac.uk/people/matt.davis/cmabridge/ (January 8th, 2019), where Matt Davis from Cambridge University dissects the text and its claims and offers explanations and useful references.

vides additional evidence for Daniels's above-discussed claim that the syllable is the preferred unit of processing (cf. Section 3.3.2.1). In the case of Thai, the syllable is not the unit of representation, since graphemes represent phonemes (or, sometimes, sequences of phonemes) rather than syllables. However, the syllable appears to be the relevant psychological grain size for reading in Thai (cf. Ziegler & Goswami 2005). In other words: the syllable is the unit of processing, at least in Thai, as Winskel (2009: 19) suggests in the conclusion of her study: it is "a more natural segmentation unit than the phoneme in reading Thai in adults and children". This claim brings us back to the fundamental question of which type of syllable could be meant here: the phonological syllable or an independent graphematic syllable (cf. Section 3.3.2.1)?

Evidence from Japanese suggests that positional transparency is "orthographic in nature", i.e. independent of phonology (Perea, Nakatani & van Leeuwen 2011: 700). In a silent reading experiment that tested the syllabic kana inventories of Japanese, users were presented target words with different following words in the parafoveal region (cf. next section), i.e. the region which is not in the focus of the eyes' fixations but from which some visual information can be extracted. In a first experiment, the words in the parafoveal region included either a transposed syllable (<アリメカ> <a.ri.me.ka.> instead of <アメリカ> <a.me.ri.ka>) or replacement syllables (<アカホカ> <a.ka.ho.ka> instead of <アメリカ> <a.me.ri.ka>). Fixations on the target words which preceded the parafoveal word were shorter when the parafoveal word included a transposed syllable, which confirms the *transposed letter [grapheme, D.M.] effect*. This effect, in general, predicts facilitation of processing of, for example, <judge> on the basis of a prior presentation of <jugde>; processing is not facilitated when the prime is, for example, <jukpe>, i.e. includes different instead of only transposed graphemes. A second experiment with Japanese kana graphemes compared fixations on the target when the parafoveal words were transposed-consonant nonwords (<a.ri.me.ka> instead of <a.me.ri.ka>) and orthographic controls (<a.ke.hi.ka> instead of <a.me.ri.ka>). The findings showed that fixation durations were remarkably similar for both conditions. Taken together, the authors interpret the results as evidence for the fact that "the locus of transposition effects seems to be quite early – that is, before phonological influences occur" (Perea, Nakatani & van Leeuwen 2011: 705).

The question of the linguistic level at which positional transparency is a relevant naturalness parameter in processing, i.e. the question of its scope, is crucial. Aside from the syllable, the morpheme and the lexeme have been discussed as relevant domains. Christianson, Johnson & Rayner (2005) found that English primes which contained transposed graphemes within morpheme boundaries elicited the transposed grapheme effect, while in primes for which transposition occurred across morpheme boundaries, no transposed grapheme effect could be observed. This is in line with the findings of Duñabeitia, Perea & Carreiras (2007), who showed that both in agglutinative Basque and non-agglutinative Spanish, transposed grapheme effects occurred intra-morphemically in non-affixed words, while no such effects occurred in affixed words across morpheme boundaries. In another study investigating transposition effects in Basque, Perea & Carreiras (2006: 421) concluded that transposition effects were not affected by lexeme boundaries in compounds, as transposition effects were very similar when they occurred in non-compound words to when they occurred across lexeme boundaries in compound words. The findings of these studies are not contradictory, as Duñabeitia, Perea & Carreiras (2007) examined morpheme boundaries between lexemes and grammatical affixes and Perea & Carreiras (2006) investigated morpheme boundaries between lexemes. These different types of boundaries appear to have a different effect on transposition effects – at least in Basque.

The fact that Thai exhibits misaligned vowels as a feature of its writing system seems to perpetuate a certain degree of positional flexibility in the processing of written Thai, which suggests the relevance of the system-specific level of naturalness. In writing systems using Roman script, transposition of the initial grapheme (e.g. *<rpoblem> instead of <problem>) hinders visual word recognition more than internal transpositions (e.g. *<porblem>), which gives the initial grapheme a privileged status (cf. White et al. 2008). In their eye movement study, Winskel, Perea & Ratitamkul (2012) found that in Thai, the initial grapheme of a word does not seem to have such a privileged status. While in Thai, silent sentence reading including nonwords with transposed graphemes proves expectedly more difficult than reading sentences without such grapheme transpositions, there appears to be no difference in difficulty between transposed initial graphemes and transposed internal graphemes. This leads to the conclusion that “actual identity of the letter is more critical than letter position in Thai” (Winskel, Perea & Ratitamkul 2012: 1532). The authors theorize that this is because processing – and what is natural and unnatural in the course of processing – is modulated by the specific characteristics of the writing system. Note that positional transparency is still a universally natural feature, but the degrees of how positional intransparency disturbs processing appears to vary across systems with different graphematic features.

Arabic and Hebrew are additional striking examples of the relevance of system-specific naturalness. As has been established before, in the writing systems of Arabic and Hebrew, only consonants and long vowels are represented graphematically. The consonant graphemes highlight the (tri)consonantal roots which occupy a central role in Arabic and Hebrew morphology. Expectedly, there is only a very minimal degree of flexibility with respect to the position of these root consonant graphemes within a word. The Hebrew root S.L.X, for example, means ‘to send’, while X.L.S means ‘to dominate’, X.S.L means ‘to toughen’ and L.X.S means ‘to whisper’ (cf. Velan & Frost 2007: 914). Transposition evidently changes meaning, wherefore consonant graphemes which make up roots cannot be transposed without causing severe difficulties in word recognition. As Perea, Mallouh & Carreiras (2010) found, transposition of graphemes in Arabic words in which the order of the root graphemes was kept intact did produce priming effects while words in which root graphemes were transposed did not, since the latter can have “the negative impact of activating the ‘wrong’ root family” (Perea, Mallouh & Carreiras 2010: 378). What the authors also emphasize is that similar to the situation in Thai, there are no significant differences between initial and internal grapheme transpositions, as transposed-grapheme effects are similar across grapheme positions as long as the sequence of root graphemes is kept intact.

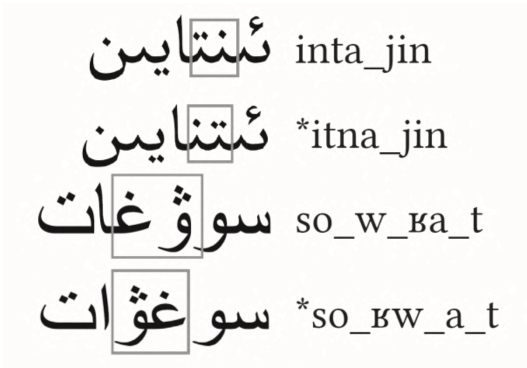

Figure 48: Transposed graphemes with changing ligations

Positional allography marks another system-specific feature of the Arabic writing system. As described in Section 2.2.2.2, graphemes in Arabic use different basic shapes dependent on their position within words. Yakup et al. (2014) tested whether grapheme transposition effects differ for words in which the transposition leads to the occurrence of a different basic shape for a transposed grapheme (and, thus, also a different ligation, i.e. a different connection to preceding and following graphemes) as opposed to words in which the basic shapes and ligation remain the same after transposition. The language they used for their experiment was Uyghur, an agglutinative language spoken in China which uses Arabic script but graphematically represents vowels. An example of a pair of transposed and correct words with the same-ligation pattern is *<itna_jin> from the correct word <inta_jin> ‘very’. The underline indicates where empty spaces are located in these words due to graphemes that are not connected to their left. In these words, the two transposed graphemes <n> and <t> were both embodied by the medial allographs in both the correct and the transposed conditions. An example for a pair in which the transposition led to a change in ligation is *<so_ʁw_a_t> from correct <so_w_ʁa_t> ‘gift’ (cf. Figure 48). Results showed that Uyghur readers had more difficulty reporting the target word when the grapheme transposition involved changes in positional allographs and ligation than when the grapheme transposition caused no such changes (cf. Yakup et al. 2014: 1604). Grapheme transposition which involves different basic shapes appears to hinder transposition priming effects. The authors take this as evidence that grapheme position is not encoded at a level of abstract grapheme identity, but at the concrete level of basic shapes, more specifically the level of positional allographs. Friedmann & Haddad-Hanna (2012) tested Arabic-speaking individuals with letter position dyslexia (LPD), a type of dyslexia "caused by a selective deficit to letter position encoding [...] which results in migration of letters within words, primarily of middle letters" (Friedmann & Haddad-Hanna 2012: 193). They presented the subjects with migratable words in which a transposition of middle graphemes either caused a 'form change', i.e. a change of positional allographs in the middle graphemes, a change of the final grapheme, a change in ligation but no change in form, or no change at all. Results showed that participants made fewer transposition errors in reading words aloud when the migration would have caused a change in allographs than when it would not have (cf. Friedmann & Haddad-Hanna 2012: 197). Positional allographs are thus helpful for individuals with LPD. This points to the possibility that positional information is part of the abstract letter identity, i.e. the abstract representation of a grapheme. This implies that there could be a discrepancy between description and psychological reality: in description, positional allographs are associated with one abstract grapheme. However, in processing, they seem to be stored independently, which means that from a processing perspective, they appear to have graphematic status, i.e. are treated as separate graphemes.

Positional transparency can be assessed not only for sequences of graphemes, but also for the arrangement of subsegmental components within a grapheme. This, of course, is again most evident in Chinese. Chinese graphemes most frequently consist of subsegmental components, and depending on their function, these components occur in a preferred position: semantic components occur on the left, phonological components on the right (cf. Taft, Zhu & Peng 1999: 498; Ho, Ng & Ng 2003: 851). Indeed, 75% of graphemes consisting of a semantic and a phonological component have their semantic component on their left (cf. Feldman & Siok 1999). This preferred position of components is "the crux of a character's orthographic structure" as it mostly "determine[s] whether the character is legal or not" (Ho, Ng & Ng 2003: 853). If components are located in their legal positions, a grapheme is either an existing grapheme or a legal pseudographeme. By contrast, if any component is located in an illegal position, the result is a nongrapheme. Implicit knowledge of component position is tested in character decision tasks in which participants have to judge whether a grapheme is a legal grapheme (either an existing grapheme or a pseudographeme) or not. Even first graders can use this type of information to reject nongraphemes and judge pseudographemes as acceptable (cf. Shu & Anderson 1999). The question of whether the representation of components is position-invariant or position-specific is not conclusively answered, with some scholars positing invariance (cf. Taft, Zhu & Peng 1999), although recent evidence gained through ERPs suggests the representation of components might be position-specific (cf. Su et al. 2012).

3.3.2.8 Figure—ground

One of the perceptually most salient features of writing is the fact that written marks visually stand out against their background. This is achieved by means of the spaces of the writing surface that shine through between (and within, as in |O|) the shapes that make up scripts. In the gestalt theoretical terms which were borrowed by NM, the writing surface is the ground, the shapes are the figure. Some of these spaces of the writing surface, which I term 'empty' spaces since they are constituted by the 'nothingness' that is visualized by the contrast with the written shapes, make visible graphetic units of various sizes (cf. Section 2.2.1.2). These graphetic units function as different graphematic units across writing systems. Notably, the size of the graphetic chunks and, in turn, of graphematic units which are visually separated by empty spaces differs across the world's writing systems.

Spacing, as a subaspect of figure—ground, is located at the graphetics-graphematics interface. Like figure—ground in general, it is a perceptual parameter, since it is manifested visually. From this perspective, spacing is a graphetic parameter which influences the legibility of a text. However, as spacing does not function randomly but makes visible graphematic, i.e. linguistic units, it is simultaneously a graphematic parameter. It does not only render a text more legible, but it also makes it more readable. This hybrid nature of spacing is reflected in how it affects processing. As a graphetic tool, it aids the guidance of eye movements in reading. As a graphematic tool, spacing facilitates the recognition of linguistic units such as words, which helps the extraction of linguistic information and, in turn, parsing processes in the course of which syntactic structures are being constructed. In the following, I will focus on how spacing affects eye movements, which I will first characterize briefly.

At the very beginning of the reading process, light waves impinge on the eye, where they are perceived by light-sensitive cells, so-called *photoreceptors*, and project two slightly different images onto the right and left retina. This is followed by sensory transduction in which the energy of the sensorial stimulus is converted into electric signals which are then transferred to the brain (cf. O'Shea 2012: 17). Reading is a complex bundle of processes: the physiological part of the task is performed by the eyes, while the cognitive task is performed by the brain. In this context, Smith (1971: 82) cautions that "[r]eading should not be regarded primarily as a visual process" since the brain not only guides eye movements and regulates when the eyes can take in visual information, but also which and how much information, since the eyes can take in a lot more information than the brain can process. Reading, thus, is a selective process in which the brain selects what of the visual stimulus is important. As long as the brain is still processing this information, the eyes cannot take in new information and send it to the brain. In fact, since the brain is constantly processing information while reading, the eyes can make only roughly four 'snapshots' per second of what they perceive (cf. Smith 1971: 90). Considering this basic architecture of the reading process, two aspects of the eyes' task prove central: *when* the eyes move and *where* they move. The eyes move in the direction of reading (whether that is left to right, right to left or top to bottom), but they do not move linearly, and they do not stop to focus on every word. Rather, they 'jump', and these jumpy movements are called *saccades*. Inbetween saccadic movements, the eyes stop at certain points which they then fixate. These breaks in eye movement are termed *fixations*, and it is only during these fixations that the brain gets the eyes to make the above-mentioned 'snapshots' and process the information that is perceived in them (cf. O'Shea 2012: 13f.). Fixations usually last between 200 and 250 milliseconds and the spatial scope that is perceived during them spans roughly 8 segmental spaces (cf. Rayner 1979: 61; O'Shea 2012: 14; Gibson & Levin 1980: 195), although both the duration and the visual intake of fixations can vary. The totality of the perceptual span (including the parafoveal and peripheral regions, see below) amounts to 4 basic shapes to the left and 15 basic shapes to the right of the fixation point, at least in writing systems using Roman script (cf. Rayner, Well & Pollatsek 1980). At a graphematic level, in alphabets, grapheme identity can be extracted from roughly 6-8 graphemes to the right of the fixation point (cf. Underwood & McConkie 1985). Sometimes, the eyes do not move forward in the text, but backward, and these movements are referred to as *regressions*. While their exact function is still unknown, they allow rereading and refixating words, for example because these words were not read correctly the first time (cf. Booth & Weger 2013). Regressions are also common in the reading of so-called *garden path sentences* in which the first parsing of the sentence is incorrect, making it necessary for readers to go back and re-parse the sentence (cf. Altmann, Garnham & Dennis 1992). On a very general level, regressions are a reflection of heightened cognitive activity.

The categorization of different regions of visual information that the eye perceives during the movements it makes proves essential for an analysis of the relevance of spacing. Rayner (1979: 61) distinguishes between the *foveal*, *parafoveal*, and *peripheral regions*. The foveal region is what is in focus during a fixation: vision of the foveal region is sharp, and the information located in it is perceived clearly. The parafoveal region is not in focus, but information can still be perceived and, to some degree, taken in. This is crucial for the understanding of the relevance of spacing: as will be shown below, spaces in the parafoveal region are relevant in saccade programming, i.e. in deciding where the target of the next saccade, the next fixation, will be located. In experiments in which the words to the right of the currently fixated word were masked, i.e. readers were deprived of parafoveal input, it was found that reading rates dropped to 60% of the reading rates expected in the normal condition in which the whole line is visible and extraction of parafoveal information is possible. The fact that information obtained from the parafoveal region guides eye movements is referred to as *parafoveal preview benefit* (cf. Rayner 1998). Finally, in the outermost peripheral region, movements and light contrasts can be perceived.

In the comparison of writing systems, one of the most-mentioned differences is whether they have spacing between 'words' or not (cf. Section 2.2.2.4). In general, these interword spaces help to guide eye movements as characterized above during the (silent) reading process. Specifically, they offer parafoveal cues that guide saccades, which – in alphabets, particularly English – are targeted between the beginning and the center of the word which is fixated next, a position referred to as the *Optimal Viewing Position* (OVP, cf. O'Regan 1990) or *Preferred Viewing Position* (PVL, cf. Rayner 1979). Expectedly, removing word spaces from writing systems in which they are an integral feature has a detrimental effect: reading processes in users of writing systems that employ Roman script are slowed down by 30-50% when word spacing is removed, which is a result of the disruption of *eye movement control* (especially parafoveal processing) and *word identification* (cf. Morris, Rayner & Pollatsek 1990; Sheridan, Reichle & Reingold 2016). Adults' eye movements while reading unspaced text are similar to the eye movements of children who have yet to master silent reading (cf. Fisher 1976). Reading without empty spaces conceals the beginnings and endings of words, information that is crucial for word identification. The removal of empty spaces interferes with the programming of saccades as no spacing information is available from the parafoveal region. As a result, saccades are shorter and land closer to the beginning of the word than to the OVP, and fixation durations become longer (cf. Rayner, Fisher & Pollatsek 1998; Perea & Acha 2009: 1994).

Information about word boundaries does not need to come from interword spacing, as Perea & Acha (2009) have shown: alternative forms of highlighting word boundaries such as the alternating**bold** manipulation, which presents unspaced text in which each other word is printed in bold, come at "some reading cost" (Perea & Acha 2009: 1999) compared to normal spaced text but leave word identification and guiding of eye movements mostly unhindered. The alternating**bold** scenario is comparable to the situation in Japanese (see below), where it is not interword spacing which provides clues about word boundaries, but the alternation of the various scripts used in the writing system.

Chinese, Japanese, and Thai (also Lao, Khmer, Balinese, and Tibetan, for example, cf. Winskel 2016: 152) are often named as examples of writing systems that lack interword spacing. For this reason, they are often used in experiments which aim to study the effect of interword spacing on the reading process, and specifically the question whether interword spacing benefits reading in systems that lack it, which is related to the finding that removing spacing from systems which usually exhibit it disrupts reading. Some of the relevant research shall be mentioned here to evaluate the status of this central subaspect of figure—ground for the graphematic processing fit.

For Thai, which has no empty spaces between words, but rather between syntactic units, various studies have been conducted to test whether the introduction of word spacing facilitates the reading process. An alternative hypothesis is that interword spacing disrupts reading in Thai since it introduces a feature to the writing system that experienced readers of Thai are unfamiliar with (cf. Winskel 2016: 153). These two hypothetical effects underline the tension between universal, system-independent naturalness and system-specific naturalness: while word spacing is assumed to be a universally natural feature for processing, the fact that some readers have acquired literacy in a writing system which lacks this feature might lead to a shift of what is natural for them in processing. One of the first studies conducted to investigate this question found that while spacing in Thai did not facilitate targeting of saccades or early lexical segmentation, it did help later word processing (cf. Winskel, Radach & Luksaneeyanawin 2009). First fixation durations were not different in spaced vs. unspaced conditions, and the same applied to fixation landing positions, which were to the left of the word center in both conditions (cf. Reilly et al. 2005). These findings were replicated in a later study (cf. Winskel, Perea & Ratitamkul 2012), which suggests that word spacing neither positively nor negatively affects eye movements in Thai while it does facilitate word processing, i.e. comprehension (cf. Winskel 2016: 158).

The Japanese writing system is an interesting case for experiments on interword spacing since the alternation of the three scripts (kanji and the two kana scripts) used in the system already provides information about word boundaries (cf. Section 2.2.2.4). When the system in its usual mixed form, i.e. with alternating scripts, is tested, the insertion of interword spacing has similar effects as in Thai. Spaced text is read slightly slower than the normal unspaced text, although not significantly (cf. Sainio et al. 2007). Interestingly, when text was presented in only kana (specifically, Hiragana), the results were similar to results from research on reading in English: spacing aided reading, although to a lesser degree (12%) than in English (30-50%). Interword spacing in Hiragana texts had a facilitative effect on eye movements and word identification. This is not surprising as the substitution of kanji by Hiragana rids the text of the word boundary cues usually provided by the alternation of these scripts and segmentation has to proceed in a way that Japanese readers are not used to (at least from their native system). Given this, what is interesting is that in Japanese literacy instruction, children are first taught the Hiragana syllabary exclusively. Since texts presented in only Hiragana offer no word boundary cues, oral recitation of texts in groups forms a crucial part of elementary reading instruction (cf. Sakamoto & Makita 1973). This echoes the practice of reading aloud to segment words in stages of Latin and Greek literacy in which no word spacing was available yet (see below).

Chinese is a third major writing system for which the introduction of interword spacing has been tested. It differs from Japanese in that it only uses one script. Consequently, no script-specific visual cues as to where word boundaries are located are provided. That Chinese has been (and still is) commonly referred to as a 'logographic' writing system should not conceal the fact that it is rather a morphosyllabic system in which graphemes represent morphemes, which simultaneously correspond with syllables. Now, since in contemporary Chinese, 66% of words (that is, 66% of 55,000 unique words in the *Academia Sinica* corpus) are bisyllabic, 66% of written words are made up of two graphemes and, in turn, two basic shapes (cf. Yen et al. 2012: 1009). The prevalence of bisyllabic words in Chinese (as well as trisyllabic and tetrasyllabic words, which are less frequent than bisyllabic words but more frequent than monosyllabic words) renders the absence of word spacing in some ways a challenge for the reading process as it means words are not just made up of single graphemes. To make matters worse, in an analysis of the *Academia Sinica* balanced corpus, Yen et al. (2009) found that only 17,8% of 5,915 unique graphemes unambiguously signal word boundaries and that the frequency with which these graphemes occur is fairly low. Word boundaries, thus, are not reliably indicated by these word boundary-indicating graphemes. In stark contrast, 49% of the 5,915 included graphemes can be used in all positions of a word. The positional ambiguity of such a large percentage of graphemes introduces a degree of so-called *overlapping ambiguity*: in 3,6% of cases, due to the positional ambiguity of a grapheme (in this example abbreviated as C2), a string of three characters C1C2C3 can be parsed both as C1C2 as well as C2C3, i.e. C2 can be both the beginning and the end of a word.

The perceptual span in Chinese covers 3 to 4 characters to the right of a fixation. Usually, this means that the foveal and parafoveal regions span a two-grapheme foveal word, a two-grapheme parafoveal word, and one more grapheme (cf. Zhou et al. 2018: 730). In their study, Yen et al. (2012) tested whether the statistical probability of C2 representing a grapheme at the beginning vs. the end of a word when occurring in a target word C1C2 in a sentence influences the reading process. They found that when C2 is more frequently used as a grapheme at the beginning of a word, parsing of a target word C1C2, in which C2 occurs in its statistically less probable final position, was more difficult for readers (cf. Yen et al. 2012: 1023).

Statistics lead to the question of which type of information readers of Chinese use in saccade programming, since saccade generation and specifically the factors that determine it in unspaced writing systems are a still poorly understood phenomenon (cf. Zhou et al 2018). As just mentioned, Yen et al. (2012) showed that statistical cues play a role in saccade programming, as the probability of a grapheme to occur at either the beginning or the end of a word appears to have an influence on the assignment of graphemes to words. However, this could be verified mainly for foveal (and not parafoveal) processing. The authors highlight that information at both the word and the grapheme levels affect eye movements. At the word level, word frequency influences fixation duration, as high-frequency words are fixated more briefly and are more likely to be skipped over than low-frequency words. Additionally, orthographic neighborhood size (words spelled similarly) and the size of the morphological family (words sharing the same base word) affect fixations and saccade programming. At the grapheme level, grapheme frequency and complexity of the graphemes' basic shapes have an effect on eye movements (cf. Yan et al. 2006). However, information at the word level can only be obtained in the foveal region, while grapheme-level information can also be obtained in the parafoveal region. This means that in Yen et al.'s study cited above, an overlapping ambiguity (C1C2C3 can be parsed as [C1C2]C3 and C1[C2C3]) which occurs in the parafoveal region does not interfere with subsequent reading performance (cf. Yen et al. 2012: 1027). This is consistent with findings from Thai, in which no parafoveal-on-foveal effects could be found when the word frequency to the right of the currently fixated word was manipulated (cf. Winskel & Perea 2014).

Regarding the question where the eyes land for their fixations, investigations of a PVL in Chinese have led to mixed results and remain inconclusive (cf. Yen et al 2012: 1010). Liu & Lu (2018: 346) claim that there exists no special landing position in Chinese, whereas Yan et al. (2010) propose a flexible eye guidance model: if sufficient information is obtained from the parafoveal region, the following saccade is targeted at the center of the word that is fixated next, whereas if not enough information is obtained, the first grapheme, or more generally, the beginning of the next word is fixated instead (but cf. Liu & Lu 2018 for a critique of this model).

Like for Thai and Japanese, it is interesting to ask what effect the introduction of interword spacing has on reading processes in Chinese. Bai et al.'s (2008) main conclusion is that neither the insertion of interword spaces nor the demarcation of word boundaries by other means (greyhighlightingofeachotherword) facilitated reading or reduced reading time (but cf. Zang et al. 2013, who found that it does facilitate word recognition). A finding that Bai et al. deem equally important is that both of these modifications of the traditional unspaced Chinese text format – interword spacing and grey highlighting – did also not interfere with the reading process. This result, however, is not interpreted as an indication that interword spacing has no effect in Chinese. Rather, it is likely that the facilitative effect offered by spacing is canceled by the deleterious effect that it has because of its unfamiliarity to Chinese readers (cf. Ma 2017: 820), which, again, highlights the conflict between the system-independent and the system-dependent levels of naturalness. In a different study, Zhou et al. (2018) tested the effects of yet another alternative word boundary cue on reading in Chinese: alternating color (which is similar to Bai et al.'s grey highlighting condition). When each other word is highlighted in color, which provides a correct lexical segmentation cue, the landing position of the next saccade tends to be close to the center of words. If the highlighting purposely provides an incorrect segmentation cue, the landing position shifts to the beginning of words. If no cue is given at all, a scenario which equals the normal, unspaced condition, Ma (2017) found that the landing position is also closer to the beginning of words. What most studies of interword spacing in Chinese have in common is that they find readers of Chinese can utilize parafoveal information on word boundaries for saccade generation if such information is available.

A different, crucial finding that Bai et al.'s (2008) study brought forth is that the word appears to have psychological reality for Chinese readers and that it is a more central unit than the grapheme or "character" (cf. also Hoosain 1992). Thus, it appears that demarcating empty spaces are not necessary for a unit to be psychologically salient or "real". Although the graphematic word does not exist as a structural unit in Chinese (at least not as defined for alphabets, cf. Section 2.2.2.4), it seems to be a relevant unit in processing.

Additional findings concerning the interaction of the system-independent and the system-specific levels of naturalness come from an experiment in which L2 readers of Chinese were presented Chinese text with added interword spaces (cf. Yao 2011). In this experiment, readers whose L1WS (= writing system of their L1) exhibits word spacing (= readers of Arabic, English, French, Italian, Mongolian, Portuguese, Russian, Spanish, and Urdu) were not affected by the addition of spaces, whereas the reading process of advanced readers of Chinese whose L1WS lacks interword spacing (= readers of Thai) was slowed down. This is striking insofar as the above-mentioned studies on Thai suggest that the introduction of word spacing to Thai texts has no disruptive effect on the reading process for L1 Thai readers, but instead even facilitated word processing (but not saccade programming). In contrast, Yao's (2011) study indicates that Thai readers who were also advanced L2 readers of Chinese were negatively affected by the addition of spacing, which calls into question the system-independent naturalness of interword spacing. According to the *Naturalness Differential Hypothesis* (Schmid 1997: 337), in L2 acquisition, a feature of the L2 that is (universally) more natural than the equivalent feature of the learner's L1 should be easy for L2 learners to acquire. Yao's (2011) findings contradict this. When native speakers and readers of Thai acquire Chinese as an L2WS, they do not have to get accustomed to interword spacing which is not a part of their L1WS, which, however, simultaneously appears to be universally natural on the grounds of the facilitative function it has for eye movement guidance and word processing. Interestingly, intermediate L2WS readers of Chinese were not disrupted by the added interword spaces, which implies that the system-specific normalcy of the lack of word spacing in Chinese may not have been completely established at this intermediate stage of L2WS acquisition.

Winskel, Radach & Luksaneeyanawin (2009) also report interesting findings concerning L2WS acquisition. In their study, they presented Thai-English bilingual readers and English monolingual readers with unspaced English text. The authors' hypothesis was that the removal of spaces would affect the Thai-English bilingual readers less since they are used to reading the unspaced writing system of Thai. This would represent a positive cross-system transfer of reading strategies (cf. Genesee et al. 2006) from Thai to English. Surprisingly, the results showed exactly the opposite: the bilinguals' reading was more severely disrupted than the reading process in monolinguals. While the reading rate for Thai-English bilingual readers decreased by 45% when interword spacing was removed, the reading rate for English monolinguals decreased only by 33%. This is in stark contrast to the findings of the previously cited study by Yao (2011) in which the reading process of Thai readers with Chinese as an L2WS was disrupted by the introduction of interword spacing.

A possible explanation for the apparently discrepant findings of these two studies is that when readers have reached a certain degree of proficiency in a writing system, the system-specific value of the feature [±spaced] is set, e.g. [−spaced] for Thai. Now, if the value of this feature is changed in an experimental condition, i.e. to [+spaced] for Thai and [−spaced] for English, this might disrupt reading regardless of the universally natural value on this parameter, which is, arguably, [+spaced]. Of course, another possible explanation could be that spacing (or any form of demarcation of word boundaries) is not actually universally natural, but given the evidence, this explanation is rather unlikely (see below). In sum, as already established in NM (cf. Section 3.1.2.1), system-specific naturalness can override universal naturalness, which both of the above-mentioned studies on reading in an L2 are in congruence with.

Another type of evidence that points to the naturalness of interword spacing comes from the history of writing. The absence or presence of spacing in the history of writing reflects the diachronic development of reading processes. As Saenger (1991: 198), whose prolific work on the development of spacing culminated in Saenger (1997), noted about reading and writing, "it should not be assumed that these same cognitive activities have been used throughout human history". The central question, now, is why in some writing systems, during certain periods, word boundaries were not demarcated and text was written in so-called *scriptura continua*, i.e. unspaced text, especially since a form of demarcation had existed prior to those periods. As Saenger (1991: 207) describes, in the earliest Greek inscriptions, words were separated by interpuncts, but Greece "soon thereafter became the first ancient civilization to employ *scriptura continua*", and that – a lot later – the Romans followed, too. It is tempting to rather drastically discard this development – the elimination of useful information for word segmentation – as a "retrograde development in human history" (Saenger 1991: 208), and under the perspective of the processing fit discussed here, this appears to be indeed accurate. However, as so often, different factors were more dominant. In this case, they were sociocultural:

> Stated summarily, the ancient world did not possess the desire, characteristic of modern civilizations, to make reading easier and swifter because the advantages, which the modern world perceives as accruing from easier reading – the swift effective retrieval of information in reference consultation, the ability to read swiftly a great many difficult technical, logical, and scientific texts, and the greater diffusion of literacy throughout all social strata of the population – were never or seldom viewed as advantages by ancients. (Saenger 1991: 208)

Indeed, the "notion that the greater portion of the population should be autonomous [...] readers was entirely foreign to the elitist literate mentality of the ancient world" (Saenger 1991: 209) is socioculturally charged. Thus, as in many other cases (cf. Section 3.3.3), the sociocultural fit, specifically the social functions that writing fulfilled in these ancient societies, were more important than the processing fit, i.e. the legibility and readability of texts. Fittingly, the reintroduction of interword spacing in the early Middle Ages by Irish and Anglo-Saxon scribes coincided with a shift in the relationship between the reader and texts (cf. Saenger 1991: 210). Also, in terms of naturalness conflicts, it is paramount to mention that once interword spacing was reintroduced, the cognitive task of separating words was reassigned to the writer. Before, in unspaced texts, it had been the task of the reader. That spacing won out in the end is in accordance with a suggested primacy of perception.

But how did the practice of reading text in scriptura continua affect reading practices and processes? Most importantly, reading at that time was not a silent activity, but an oral activity. Reading aloud helped readers store in short-term memory the fragments of the text that had already been read, which allowed cognitive processes to be allocated to not yet decoded fragments (cf. Saenger 1991: 205). As Saenger (1991: 205f.) adds, readers were not entirely without help when reading scriptura continua as scribes made larger the spaces between individual basic shapes. He also points out the striking similarities of these ancient texts with texts designed for beginning (and often, oral) readers nowadays. These modern texts, too, often place larger empty spaces between individual basic shapes and also increase line spacing. This echoes what ancient scribes did with their texts to aid reading out aloud.

The fact that Greek and Latin are the most well-known instances of scriptura continua is no coincidence. Saenger (1991) describes how a fully (or almost fully) voweled segmental writing system – which means alphabets and abugidas (cf. Section 2.3.2) – is a prerequisite for scriptura continua to function. By claiming this, he likely implies that a lack of both vowels *and* word spacing would render a writing system too complex for processing. Accordingly, other ancient writing systems such as those of Mesopotamia, Phoenicia, and Israel "invariably contained separation" (Saenger 1991: 207). For Hebrew, Saenger (1991: 202) additionally mentions visual complexity as a factor that makes interword spacing necessary, as even in the presence of both vowels and interword spacing, the visual similarity of the basic shapes of Hebrew script makes word recognition more difficult than in systems in which basic shapes are more distinctive.

What was discussed up until this point was the presence vs. absence of interword spacing. What has not been mentioned thus far is *where* exactly interword spacing occurs. When terms such as "interword spacing" are employed, in some writing systems, because of the structure of the underlying language system, it is not straightforwardly obvious where, i.e. between which units spaces of this type should be located. For German, with its complex morphology and abundance of compounds, the presence or absence of spacing in complex words (and the identity of these 'words') is a heatedly debated topic, both from the perspective of graphematics (cf. Jacobs 2005; Fuhrhop 2007) and orthography (cf. Mogensen & Møller 2001 for the reform of rules pertaining to spacing; Herpel 2015 for a historical overview of the treatment of orthographic rules pertaining to spacing in the 18th and 19th centuries). I would argue, however, that this question of *where* spaces should be located is not a question of figure—ground, but a question of (unit) transparency (cf. Section 3.3.1.4), as it concerns the question which linguistic units are made visible through spacing and whether it is consistent in its function or whether it is opaque as it potentially makes visible different types of linguistic units.

Another example for figure—ground is the visual contrast between more salient lowercase basic shapes which exhibit the feature [+length] and less salient lowercase basic shapes which lack this feature in alphabets employing Roman script. For German, it could be shown that long basic shapes, which are used to embody consonant graphemes and occur at syllable boundaries, have a facilitating effect on reading (cf. Drews 2011; Fuhrhop & Schreiber 2016). As with interword spacing, the presence of a salient figure—ground contrast provides the eyes with additional information about distinctiveness which can be used to aid segmentation. In this case of marking syllable boundaries, this could prove especially helpful since ample evidence suggests that the syllable assumes a special status in processing (cf. Section 3.3.2.1).

3.3.2.9 Additional parameters

As already mentioned in the context of the linguistic fit, it is expected that there are additional graphematic naturalness parameters that were not treated in this chapter. One of them that was already mentioned is *optimal shape*. While the optimal shape of a sign cannot be assessed descriptively, for processing, it can be evaluated. A reasonable, though not unproblematic indicator of an optimal shape for processing could be word length. Word length assumedly affects cognitive processes such as working memory, but it also affects eye movements: as outlined above, the eyes perceive information from the parafoveal region, and information about the length of upcoming words – quantified in the number of graphemes they include – could influence saccade programming. This information, of course, is not universal across writing systems. Some provide it in the form of empty spaces, Japanese provides it in the form of the alternation of its scripts, Thai might provide it in the form of statistical information on which graphemes occur at syllable boundaries. How saccades are programmed in Chinese is, as mentioned, not conclusively answered. As the brief sketch of this parameter shows, physiology and cognition interact in crucial ways, and it is this interaction which will also be vital in uncovering additional naturalness parameters.

3.3.3 Sociocultural fit

> [...] literacy must respond explicitly to the needs of the specific speech community involved. (Jones & Mooney 2017: 5)

Unlike the sociocultural fit of scripts (cf. Section 3.2.3), which is concerned with how sociocultural factors interact with the visual appearance of a writing system, the sociocultural fit of the graphematic module opens up a larger sociolinguistic perspective. It subsumes the sociocultural fit of scripts, and it more generally evaluates whether a writing system is socioculturally suitable for a given language, or, more specifically, a language community. To answer this question, the sociocultural fit takes into account a language community's complex cultural, historical, geographical, etc. context. It mostly revolves around external needs which stem from the status that writing, as a cultural technique, occupies in our society and, at a more local level, in specific literate communities. Frequently, writing systems are instrumentalized as tools meant to fulfill political functions (cf. Coulmas 2000: 47). Consequently, it would be fatal to reduce them to their linguistic and processing fits, since "[i]n interaction with humans, writing does a lot more than represent speech [rather language, D.M.] visually. The technological agency of writing turns out to be not a transcription system and memory record but *a tool for solving social problems*" (Weth & Juffermans 2018: 7, my emphasis). Writing, as a tool of this kind, is "a symbolic resource with unique affordances for the construction of languages and projects of self-identification" (Abdelhay, Makoni & Makoni 2018: 97). In the present section, I outline some of the main considerations that factor into the sociocultural fit of writing systems. In analogy to the treatment of the sociocultural fit of scripts, what will take center stage is the creation of new writing systems for yet unwritten languages, a process that proves illuminating with respect to sociocultural factors and has spawned an abundance of literature which elucidates literacy development from various perspectives. Furthermore, the possibilities of sociocultural variation within already established writing systems and the interaction of this variation with the linguistic and processing fits will be addressed.

This is not the place to discuss the general question of the naturalness of *literacy* vs. *orality* (for a thorough discussion cf. Ong 2012; for an overview cf. Dürscheid 2016: 53-61). However, it is paramount to keep in mind that literacy and orality interact and to understand that "writing can be critiqued by and of itself as well as on ideological grounds as a tool used by human beings" (Weth & Juffermans 2018: 1). This invites a critical analysis of how writing is used as such an ideological tool. In this vein, aside from evaluating different writing systems and comparing them with respect to their sociocultural fits, which is done in the following, the ideological undertones of literacy vs. non-literacy (which is not to be equated with orality) could also be compared. In their introduction to the volume *The tyranny of writing*, Weth & Juffermans (2018: 3) note that "literacy is still very unequally distributed in the world". Illiteracy, which was "once a normal state of affairs[,] is now considered a disadvantage and an obstacle to human and social development" (Coulmas 2003: 225). Whether a language has or lacks a writing system is a factor that hierarchically distinguishes it from other languages. Even within a single language, the dialect that is chosen as the basis for the written standard is perceived as having a preferred status compared to the other dialects (cf. Section 3.4).

Writing is all about social choices. These choices can be neutral or socially charged (Sebba 2009: 38). Frequently, they are socially charged and, as mentioned above, used as ideological tools when "human beings […] individually and collectively use or abuse writing in making social distinctions, intentionally and consciously or otherwise" (Weth & Juffermans 2018: 7). One of the fundamental aspects of writing that allows its instrumentalization in such a way is its inherent normativity. With respect to normativity, the effect that writing has on the spoken language in literate communities must not be underestimated: the evaluation of correct or wrong pronunciations, or, on a higher level, the evaluation of good spoken "sentences" (cf. Dürscheid 2016: 57), demonstrably reflects the transfer of written norms to the spoken language (cf. also Karg 2015: 28-33). The hybrid functional nature of both writing and speech is captured by a conceptual distinction that has been tremendously impactful in the German-speaking realm: Koch & Oesterreicher's (1985, 1994) continuum of *orality* and *literacy*. In their conception, the dimension of *medium* – whether a text is medially, i.e. materially, written or spoken – is divorced from the *conceptual* dimension. This distinction allows acknowledging that, for example, texts which are medially spoken can be conceptually written. This is precisely the case with academic presentations at conferences: medially, they are spoken, but their structural makeup, register, and style, marks them as conceptually written. The inverse is true for many types of informal CMC (computer-mediated-communication): consider text messages in applications such as WhatsApp which are often conceptually spoken although they are commonly medially written (for a more thorough discussion of Koch & Oesterreicher's concept, cf. Dürscheid 2016: 43-53). In any case, the interaction between the variables written vs. spoken on these two dimensions proves that there is no 'great divide' between literacy and orality. Instead, there is a continuum.

The impact of *autonomous literacy*, i.e. reading and writing as technical skills divorced from any social context, must not be overestimated: what Goody & Watt (1963) proclaimed as consequences, or, less neutrally phrased, *benefits* of literacy – the ability to think analytically, abstractly, and logically, to specialize and compartmentalize knowledge, to store and chronologically order knowledge, among others – might not be direct consequences of literacy *per se*. In fact, "the view that, in order to become socially and cognitively equal, preliterate societies must become literate has [...] been discredited" (Jones & Mooney 2017: 4). A "concept of 'traditional literacy' [...] associated [...] with 'formal, Western-style' education" is thus "too restrictive and inapplicable" for the socioculturally diverse contexts of literacy development (Jones & Mooney 2017: 4). This is in line with what Scribner & Cole (1981) suggest on the basis of their study which focused on non-formal education: the above-mentioned 'benefits' are not directly related to literacy as a technical skill, but instead to education, which leads to the conclusion that "context-independent abstract thought, memorization skills and logical thinking are actually more correlated to schooling and urbanism than literacy as the mere ability to read and write" (Weth & Juffermans 2018: 9). What matters, thus, is not the acquisition of literacy *per se*, but the social circumstances in which it is acquired, and that literacy is not just interpreted as a technical skill, but "involves the acquisition of knowledge about how to apply these skills in specific contexts and for specific purposes" (Jones & Mooney 2017: 4). These conclusions are emphasized by the paradigm of *New Literacy Studies* (cf. Street 1984; Barton 2007) which focus on the sociocultural aspects and contexts of literacy.

Another approach closely linked to Scribner & Cole's investigation of non-formal education is the study of so-called *grassroots literacy*, defined as "writing produced under poor material and infrastructural conditions and at a distance from the institutions of prescriptive and elite-linguistic normativity" (Weth & Juffermans 2018: 10). Not unlike writing systems in the past, at a time when no prescriptive orthographies (cf. Section 2.2.3) had emerged, grassroots literacy exhibits a high level of variation as it lacks orthographic regulation. It is free of many of the socially charged tensions that persist in more elaborated and established literate communities. This provides a strong indication that it is not literacy that is used as an ideological tool, but its instrumentalization by humans. Orthography and the prescriptivism associated with it are at the core of that instrumentalization. Despite counterexamples such as grassroots literacy, literacy, in general, is commonly not divorced from social 'baggage', and it is not defined "as some decontextualized 'ability' to write or read, but the social practices into which people are apprenticed as part of a social group, whether as students in school, letter writers in a local community, or members of a religious group" (Gee 2008: 80).

To conclude this introductory excursus, attitudes towards literacy always appear to be ideologically charged. This becomes obvious when literate societies are equated with modern societies or when illiteracy is seen as an indication of insufficient education, failure or economic disadvantage (cf. Coulmas 2003: 223). These considerations will not play a prominent role in what follows, where the focus lies on the comparison of literate communities. However, since the sociocultural fit of writing systems is most crucial in the process of the creation of new writing systems, a process also known as literacy development, the mentioned attitudes associated with literacy, non-literacy, and orality should be kept in mind.

Lists of criteria which have previously been used to evaluate writing systems (cf. Section 3.1.1) almost always include sociocultural factors of some kind. Often, these are given the label "sociolinguistic factors", where 'sociolinguistic' "can be taken as a broad term covering a range of social, cultural, and historical aspects" (Sebba 2009: 36). Together with psychological and pedagogical considerations, they are sometimes subsumed under the heading of "non-linguistic factors" (cf. Seifart 2006; Cahill & Karan 2008; Cahill 2014), which corresponds with the present threefold distinction between the linguistic fit on the one hand and the processing and sociocultural fits on the other. These sociolinguistic factors include top-down factors such as political governmental policies, which, however, more often regulate orthographies than writing systems (for the difference in regulation, see below), sociocultural factors such as dialects, relationships with and attitudes towards other literate communities, the transferability of the writing system to other languages, and technological factors such as the material available and the question whether a script used for a writing system is encoded in Unicode (cf. also Section 3.2.3).

At the outset of a discussion of these sociocultural factors, it must be noted that they cannot be measured as straightforwardly as the parameters of the linguistic or processing fits as they are often of very subjective nature and must therefore be individually assessed. Furthermore, what is natural socioculturally for a given community can frequently not be decided from the outside, as it is often a matter of internal negotiation. The grapholinguist investigating these aspects must thus imperatively consider the discussions that are internal to the community. Despite its fuzzy nature, the sociocultural fit is arguably the most important of the three fits. In fact, the success or failure of a writing system hinges on it, as Cahill (2014: 16, emphasis in original) notes:

> People accept or reject an orthography based on sociolinguistic factors. If a group doesn't *want* to use an orthography, it doesn't matter how linguistically sound it is – they won't use it. So "what the people want" is not just one more factor; it is the *most critical* factor in *acceptance* of an orthography.

In other words, a writing system that is not accepted by its community has effectively failed (cf. also Jones & Mooney 2017: 23; Hinton 2014: 144), and what a community judges is primarily the sociocultural fit of a writing system, not its linguistic or processing fits. The specific character of the sociocultural fit results in a situation in which general naturalness parameters can be identified, but no universal naturalness values on these parameters can be proclaimed, since what is natural on a given parameter always depends on the needs and wishes of a specific community. The naturalness parameters, thus, are located at a level of system-independent naturalness, but their respective natural values are always located at the system-specific level. From this follows that the sociocultural fit is not primarily relevant in the explanation of the natural features in a writing system, but, perhaps, in the explanation of some of its seemingly idiosyncratic, unnatural features which might just be the result of the fact that the sociocultural fit is often assigned more weight than the linguistic and processing fits.

As mentioned above, in our modern world, literacy is widespread, but it is far from being ubiquitous. There still exist many communities that lack writing systems for their languages. This is the context of so-called *orthography development* (cf. Lüpke 2011), also referred to as *graphization* (cf. Jones & Mooney 2017: 1) or *literacy development*. The study of these creations of new writing systems for unwritten languages is more central to the sociocultural fit than the study of writing systems which have been in use for a long time as they show the sociocultural factors discussed in this section 'in action'. Indeed, in many creations – or, in most cases, adaptations – of writing systems described in the literature, sociocultural factors prove pivotal. When compared to *ancient grammatogenies*, i.e. instances in which writing was created from scratch, the creations of writing systems in the context of literacy development are of special interest since they occur in "controlled" environments. Usually, linguists or scholars with other areas of expertise are on scene, working together with a community – sometimes also without community involvement – on the task of giving a language a writing system. In these cases, thus, there is always an outside specialist of some kind collaborating with members of the community, i.e. people on the inside. The outsiders who work on giving communities literacy are referred to as *script mediators*, *orthography mediators*, or *orthographers* (cf. Sebba 2009: 41; Jones & Mooney 2017: 1); many of them have been or are members of the *Summer Institute of Linguistics*. They can describe and have described the sociocultural factors as they encounter(ed) them at work, which renders their accounts of the influence of sociocultural factors on a writing system's naturalness not *a posteriori* explanations, but first-hand descriptions of what could actually be observed in the course of literacy development. This is also the reason I will focus on these instances of literacy development in most of the remainder of this section.[309] Conversely, for older grammatogenies in which no outsiders were involved (which, however, was less often the case, cf. Sebba 2009: 41), one can often only attempt a historical reconstruction of the circumstances that led to specific choices.

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[309] I will focus on the creation of writing systems in general and not on the creation of writing systems for endangered languages, an even more complex situation that requires a careful consideration of many additional factors (cf. Jones & Mooney 2017).

Following Fasold (1984), who described factors relevant in the choice of national languages, Unseth (2005) lists three sociocultural factors that play a crucial role in the creation of a writing system: (1) identification with a group, (2) distancing from a group, and (3) participation in developments on a larger scale. Smalley (1964) proposes a different kind of characterization. As mentioned in Section 3.1.1, his criteria are meant as evaluation devices which allow assessing the quality of a writing system and, consequently, the comparison of different writing systems. Of his five criteria, three are of sociocultural nature: (I) maximum motivation for the learner and acceptance of a writing system by society and controlling groups such as the government, (II) maximum transfer, and (III) maximum ease of reproduction. Unseth's above-listed categories give this section its overall structure, with Smalley's criteria being discussed at points at which they are of relevance.

One of the central factors in the creation of writing systems, and the first one listed by Smalley, is (I) maximum motivation for the learner. It can only be achieved if the learner, interpreted here as a member of a specific literate community, is invested in a writing system, which requires that he accepts it. Indeed, in most of the literature on the topic, it is emphasized how important it is to involve the local community and what detrimental effects it can have if specialists working on a new writing system fail to do so (cf. also Karan 2014: 132).[310] Whether a community supports the externally-controlled efforts of introducing literacy must be assessed by checking whether a number of criteria are met:

> (i) the usefulness of a literacy programme must be recognized and approved by traditional community members (e.g., elders, politicians, religious leaders); (ii) local contexts for literacy must be identified and approved by community members; (iii) there must be continued widespread use of the endangered language [or generally the language that is to be written, D.M.]; (iv) there must be support for the maintenance of local literacy by (local) educational systems.
>
> (Jones & Mooney 2017: 6)

An additional criterion is the consideration of pre-existing writing systems, also referred to as *legacy orthographies* (cf. Jones & Mooney 2017: 30). If there already exists a writing system in a community, this must be taken into account. It must be carefully assessed who uses an existing legacy orthography and how accepted it is within its community. Note that in such a situation, the purpose of literacy development shifts from the creation of a new writing system to, basically, the reform of an existing writing system.

The development of a writing system and, on a larger scale, the implementation of a literacy program should only proceed if all of the above-mentioned criteria are met. One way of gaining "native-speaker input" (Jones & Mooney 2017: 24) is by forming committees with members from all dialects or varieties of a language who, together with linguists, should be invited to work on creating a writing system (cf. Grenoble & Whaley 2006: 156). This, of course, can prove a challenging task if no members of the community are literate in any language or have not had prior access to formal education (cf. Cahill 2014: 22).

Before I go on to discuss Unseth's (2005) criteria, I want to highlight that the first two of them are based on the same parameter of sociocultural naturalness: *indexicality.* While the indexicality discussed in the context of the linguistic fit in Section 3.3.1.3 was endophoric, the indexicality referred to here is of exophoric nature. Writing systems, with respect to both their material and linguistic levels, can index a multitude of social variables that lie outside of themselves and language, which is precisely the meaning of 'exophoric' in this context. Additionally, I propose two subtypes: *intrasystemic exophoric indexicality* and *intersystemic exophoric indexicality.* The examples discussed below highlight communities' wishes to express belonging or

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[310] There are instances in which people from the outside made decisions without consulting members of the community that was affected by these decisions. A striking example comes from the *Rejaf Language Conference* held in 1928 in the Sudan where linguistic and orthographic matters were discussed with "'native voices' conspicuously absent" (Abdelhay, Makoni & Makoni 2018: 100). Another example is literacy development in Micronesia in the 1970s where the community did not accept the orthographies devised (cf. Yunick 2000; Rehg 2004).

distanciation from other groups and are of the intersystemic type as they involve the relation between two writing systems. In a later portion of the section, I will also turn to intrasystemic exophoric indexicality, which is crucially dependent on grapholinguistic variation and is focused on how certain features *within* one writing system can be interpreted indexically.

The writing systems of Arabic and Chinese serve as fitting examples for Unseth's first category, (1) *identification with a group*. In both of these languages (or groups of languages), there is a diglossic situation. Although there exist many spoken dialects of Arabic, the written language is the same for all: *Modern Standard Arabic* (MSA). This presents a challenge for children in literacy acquisition, since the language they learn to write differs in many respects from the language they speak (cf. Saiegh-Haddad & Spolsky 2014). Socioculturally, however, it means the Arabic writing system – and not only its script with its characteristic visual appearance – unites the Arabic realm, which has intricate cultural and religious consequences. Chinese, too, is not a single language, but a collective term for a number of spoken varieties:[311] while some linguists classify these varieties as dialects, others choose to treat them as separate languages, mostly because they are mutually unintelligible (cf. Chen 2004). The choice of treating them as dialects of one language is politically motivated. It is enforced by the fact that all of these varieties use the same writing system and, since that writing system is morphographic, can communicate with each other by means of this writing system. As evidenced by these examples, the Arabic and Chinese writing systems serve as tools for political and cultural unification. Note that in both cases, however, some varieties are advantaged: what is often discussed under the heading of "dialects" in orthography development is the fact that a unified writing system which is employed by a range of spoken linguistic varieties must inevitably favor some varieties (whether languages or dialects) over others. This means that for the speakers of some Arabic varieties, the diglossic situation constituted by the linguistic distance to the formal written standard will be not as challenging as it is for other varieties since their variety is linguistically closer to the standard. It is similar for Chinese, where a Beijing dialect of Mandarin serves as the standard. Consequently, children with this specific dialect as their L1 are advantaged in acquiring the writing system while other people are generally disadvantaged both in the acquisition and use of the writing system. As Li (2018: 149) remarks, "speakers of Chinese 'dialects' such as Cantonese do not have the benefit of 'writing as one speaks'" (see below).

The examples provided so far were concerned with the unity of one cultural or political whole, as, for example, by using the same writing system, users of different Arabic varieties convey that they are a part of an overarching Arabic culture. However, this aspect of wishing to identify with a certain group through writing frequently concerns hierarchically asymmetrical situations which involve a dominant language (and writing system) and a "subordinate" community seeking to show affiliation with that dominant language. The wish of signaling belonging, thus, is often a cross-cultural factor in which the influence of other, especially geographically neighboring cultures, countries, and languages as well as their writing systems is of utmost importance (see below for the relevance of contact phenomena). Of special interest in this respect is Smalley's criterion of *transfer* which evaluates how easily the knowledge acquired in learning to read and write a newly created writing system can be put to use when acquiring a second writing system, in Smalley's sense a "dominant" writing system that is participating in developments on a larger scale (see (3) below). "Knowledge", as used here, pertains predominantly to the graphematic module and competence with respect to graphematic relations. In a study which highlights processes of graphematic transfer, Hinton (2014) differentiates between so-called *English-based Practical Orthographies* (EPOs) and *Linguistic Practical Orthographies* (LPOs). She observes that linguists coming from the outside to devise a writing sys-

311 For this reason, the practice of referring to the cluster of varieties as 'Chinese' that is adhered to also in this thesis is not unproblematic. However, within the scope of this study, it is somehow also fitting since this is a study about writing and the Chinese writing system is what unites the different spoken varieties of Chinese. The phonological representations given for Chinese morphemes in this thesis, though, are taken exclusively from Mandarin.

tem for and with a community often prefer "code-internal" design factors (Hinton 2014: 139). This means that in their design of a writing system, they prioritize the linguistic fit (and, through this detour, the processing fit) and prefer LPOs. The communities themselves, however, most frequently favor "code-external considerations". The communities that Hinton describes are heavily biased by their familiarity with the English writing system, which results in a preference of EPOs. This leads to a situation in which at least some of the graphematic relations of the English writing system are adopted by the new system even if they interfere with the linguistic fit, i.e. do not fit the underlying language system. Consider Hinton's (2014: 142) description of multiple programs striving to revitalize American Indian languages:

> In a growing number of cases, the community leaders of the language programs thus developed are dominant in English, and being highly literate in English, they may insist on utilizing English spelling rules in the writing systems for their heritage languages. These English-based Practical Orthographies [...] are becoming more common and are sometimes even replacing already-established LPOs.

Hinton also uses Smalley's (1964) five original criteria (cf. Section 3.1.1) as a basis for her study and claims people "will always use ease of learning and especially maximum transfer as their highest criteria and will therefore fall back on writing systems that reflect their knowledge of the dominant language orthography" (Hinton 2014: 146). This is not the place to discuss at length how this adherence to dominant languages is problematic (especially under the perspective of *colonial linguistics*, cf. also Abdelhay, Makoni & Makoni 2018), but I do want to point out how striking it is that communities commonly rather wish for their writing systems to be more like different writing systems than to find their own 'written identity'. Smalley (1964: 36) gives this telling example:

> In Latin America many a missionary has worked out a splendidly consistent writing system based upon linguistic principles and the use of a practical phonemic alphabet. He has usually found, however, that he needed to modify that system in the direction of Spanish spelling usage, even where it introduced a limited amount of inconsistency. The influence of 'educated' bilinguals, the prestige of identification with Spanish culture, and the elements of transfer value have all united to make new literates want to learn a system as close as possible to the prestige language around them.

As described in Section 2.2, it is, in theory, possible to merely adopt a script. However, what is commonly adopted along with a script is (part of) the graphematic module of a dominant writing system. The writing system itself cannot be adopted since a given writing system is always intricately linked to an underlying language system. However, the graphematic module of a writing system can be adopted in that its graphematic relations can be "reassociated" with analogous linguistic units of the language that underlies the target writing system. Ultimately, this means that not only basic shapes, but also their graphematic values are adopted: in the above-mentioned EPOs, the vowel grapheme <a>, for example, will represent phonemes that are similar to the ones it represents in the English donor writing system. Smalley (1964: 45) mentions a noteworthy example of a situation in which, in his opinion, the criterion of "maximum transfer" was gravely violated: in some early attempts to write tribal languages in Thailand using the Thai writing system, the basic shapes and their graphematic relations were adopted. However, one particular feature of the Thai writing system was discarded: the non-linear arrangement of vowel graphemes that is typical of abugidas (cf. Section 3.3.1.7). Instead of spatially arranging the vowel graphemes on every side of the consonant graphemes (left, right, top, bottom) as is usually done in Thai, the Thai-based writing systems for tribal languages "simply used the symbols but with Roman sequence of left to right" (Smalley 1964: 45). This greatly diminished the degree of transferability of these Thai-based writing systems as their readers knew Thai graphemes but were not familiar with their spatial arrangement in Thai.

At this point, a crucial difference between original Naturalness Theory and Natural Grapholinguistics must be emphasized: when it comes to the use of scripts and, to some degree, even the basic graphematic relations of writing systems, frequency cannot serve as a heuristic to evaluate what is (more) natural in writing, at least not in a straightforward manner. This is largely due to the circumstances described above: the choice of a script, and in general, the creation of a writing system, are processes that are intricately (and inseparably) linked with sociocultural factors. The fact that so many writing systems of the world employ Roman script, for example, cannot be seen as evidence for a claim that Roman script was the most natural one (cf. Sebba 2009: 41). Rather, it is power relations that are reflected in this very ubiquity of Roman script. It is related to the missionaries who act as orthography mediators and propagate the use of Roman script, and, of equal importance, the own wishes of communities to link themselves to dominant groups who already use Roman script. Different degrees of these power relations can be conceptualized as a continuum: there are writing systems that merely choose to use Roman script while retaining only a few of the graphematic relations of their donor language (be it Spanish, English, French, etc.) on the one end of the continuum and writing systems that employ nearly all of the same graphematic relations, or as many as the structure of their own language allows on the other end.[312]

(2) *Distancing oneself from a group*, or *ideological distanciation* (cf. Jones & Mooney 2017: 25), is a second factor and the polar opposite of the wish of identifying with a group. It is a strategy, which, in cultural studies, is also referred to as *othering* (cf. Dervin 2012). A whole slate of cases that fall into this category is characterized by communities that wish to "create ideological independence from former colonial powers" (Jones & Mooney 2017: 25). In general, as Unseth (2005: 24) notes, the wish to signal distance from a particular group can be fueled by "ethnic pride, desire for political autonomy, religion", adding that "these categories are not mutually exclusive". All of these three factors play some role in the two most well-known examples of this strategy: while they both use alphabetic writing systems, the Orthodox Serbs use Cyrillic script for their writing system, while the Catholic Croats use Roman script for theirs (and the situation is even more complex, as Serbs use both scripts based on a variety of factors, cf. Section 3.2.3). Similarly, Urdu employs Arabic script – and with it, an abjad – and Hindi uses Devanagari for a writing system that is typologically an abugida. Even though Urdu and Hindi are, in spoken language, mutually intelligible, "the cleavage between [them] is experienced so strongly by many speakers that they deny intercommunicability" (Coulmas 2003: 232), and this is reinforced by the use of different scripts. Another example is the abolishment of Chinese characters – in Korean called *hancha* – in North Korea, while they are – even though in a very limited way – still in use in South Korea (cf. Coulmas 2016: 48-50). This abolishment in North Korea was, of course, motivated by political reasons. In extreme cases, as Unseth (2005: 25) comments, the wish to distance oneself from another group is expressed by creating a new writing system instead of adopting an already existing one. This, in many cases, involves also the creation of a new script (since scripts are, in the case of literacy development, often interpreted by communities *pars pro toto* as the writing systems that they visualize). In the context of script creation, as discussed in the sociocultural fit of scripts (cf. Section 3.2.3), the desire for dis-identification can be so strong that it can even affect the visual makeup of the newly created shapes in a way that makes them as dissimilar from another script as possible (cf. Unseth 2005: 26).

A very illustrative example for the strategy of distanciation is given by Unseth (2005: 24): the Daasanach are a people who live at the Ethopian-Kenyan border. The large majority of them (over 30,000) lives in Ethiopia, while a small fraction (of only over 2,000) lives in Kenya. However, the only literature in their language has been produced in Kenya using Roman script. On the Ethiopian side of the border, the sociocultural situation is a bit more complex: there, Roman script is already used by the Oromo, a people whom the Daasanach feel dominated by. This is cited as the reason why the Ethiopian Daasanach decided to use the Ethiopian syllabary instead of Roman script to write their language. This is a perfect example for system-specific

[312] For example, for a target phonographic writing system to adopt the graphematic relations of a source phonographic writing system, the phoneme inventories of the two languages have to exhibit some similarities, they have to overlap. Otherwise, graphematic relations could not be successfully reassociated with the same type of phoneme in the target language.

sociocultural naturalness on a very small, local scale: for the Ethiopian Daasanach, the use of the Ethiopian syllabary, or, more precisely, the non-use of Roman script which is already used by the Oromo is natural since it marks a social distance from the people they do not identify with and by whom they feel dominated. This, as so often, goes against naturalness with respect to the linguistic fit, and, probably, the processing fit. In the Ethiopian syllabary, it is not possible to indicate vowel length, which, however, is phonemic in Daasanach. Also, Daasanach has some consonants that are not available in the Ethiopian syllabary and, thus, cannot be written (cf. Unseth 2005: 24). Furthermore, not only the linguistic and processing fits are violated by this choice, but also other parameters of the sociocultural fit: because of their wish to distance themselves graphematically from the Oromo, the Ethiopian Daasanach automatically also distance themselves from the Kenyan Daasanach who, like the Oromo, use Roman script. Seen under a broader perspective (see below), they also choose a rather marginal script and writing system with respect to the participation in global affairs. Choosing Roman script would have been more natural in that regard, since it would have opened up doors for the acquisition of internationally important languages and the use of so much readily available technology suited for Roman script.

China's insistence to keep its morphographic system despite some efforts to Romanize or alphabetize it is another process that can be placed into this category (cf. DeFrancis 1943). As many accounts have described, China sticking to its morphographic system is mainly due to the expression and preservation of cultural and traditional continuity. Chinese writing, as the product of one of the original independent ancient grammatogenies, is the oldest writing system still in use today. Changing it would not only equal an abandonment of thousands of years of culture and history but would also feed into the Eurocentric criticisms that have discarded the Chinese (and Japanese) writing systems as being less efficient than alphabets (cf. Hannas 1997). This view has been largely superseded today, given the cultural prosperity of not only China, but also Japan and other Asian cultures, and especially their economic force, their high literacy levels and in general, their high levels of education (cf. Sampson 2016: 564).

The third major sociocultural factor is (3) *participation in developments on a larger scale*. It boils down to the fact that the choice of a writing system "clearly influences a group's preparedness to interact with other groups outside their circle, regionally or internationally" (Unseth 2005: 27). A number of subfactors must be considered. First of all, as already mentioned in Section 3.2.3, the choice of script. In the creation of new writing systems, the choice of script is often influenced by the wish to not only be associated with a different, in most cases dominant, group (see (1) above), but also by the wish to be able to communicate with that group. Superficially, in a first step, this means using the same script, be it Roman, Cyrillic, etc. The wish of being able to communicate at a more global level is also influenced by technological factors, which are subsumed by Smalley's (1964) criterion of (III) maximum ease of reproduction. Already existing scripts which are often used by many writing systems across the globe usually exhibit a high level of technological implementation. Take Roman script, for which, one could argue, most modern technology is specifically tailored, beginning with typewriters, or more modernly, keyboards, input methods for mobile phones, tablets etc. Other scripts are not as overrepresented in technology, but there still exist solutions for many of them: consider the phonetically-based input methods for Chinese and Japanese. Even if it is through an alphabetic detour, these morphographic (and syllabic) systems can be used on most technological devices as well. Many – though certainly not all – scripts of the world that are in use today are also included in Unicode and can be written electronically, which means there are fonts available for them (cf. Dürscheid in press). Hence, today, the importance of technological factors is "diminishing with the rapid development of computer software" (Unseth 2005: 28). This means that while Roman script is without a doubt the "most natural" choice with respect to the technological fit, on a continuum, other existing scripts also fare well. What is categorically dispreferred, however, is the creation of a new script from scratch (cf. Section 3.2.3), since such a script would be, at least at its very inception, technologically ill-equipped. It would not only be a visual and, in turn, linguistic barrier in the communication with other languages and their writing systems (see below), but also a disadvantage in a purely technological sense. However, it would allow drafting a script and writing system that is intimately tied to a specific community or culture. This highlights that different parameters of the sociocultural fit are in conflict.

Once the visual appearance of a writing system has been decided on, in the next step, what is important is the possibility of transfer that was already discussed under (1) above. If some of the graphemes of a new writing system are "borrowed" graphemes from English, for example, in that they relate the same basic shape with the same type of phoneme (albeit in a different language), then this can greatly facilitate spelling acquisition as a part of L2 English acquisition by the speakers – and new writers – of the language that received the English-based writing or EPO. Since English is so dominant internationally, this puts people whose writing systems are based on the English writing system at a certain advantage.

What conclusion can be drawn from the three factors discussed above? One conclusion is that what counts as socioculturally natural is what a community agrees on internally. This cannot be overwritten by external orthography mediators and their rational reasoning. All of the three aspects named by Unseth might converge when a community wants to distance itself from a group that oppresses them but simultaneously wishes to move graphically closer to a different (most often also dominant) group and its language, which, in turn, could – provided that this language is relevant politically in a more global, probably even international manner as well as suited technologically – even allow it to participate in developments on a larger scale. However, what is important for all three of those factors, and what conflicts with them, is what I argue is the most universal naturalness parameter of the sociocultural fit: *availability* and *accessibility*. In a literate community, literacy should be available and accessible to as many members of the community as possible. This calls for a differentiation between external and (relatively) internal factors. Factors such as education or economic status of the members are external: these are political factors in a given community which are, of course, very likely to affect the literacy of its members. However, they cannot be used to assess the sociocultural naturalness of a writing system since they are external. Two factors that are internal are the (a) choice of a standard variety and (b) the choice of a writing system whose technology is most accessible to everyone.

The (a) *choice of a standard variety* was already mentioned above in the context of Chinese and pertains to the fact that of the many dialects that may be spoken in a language community, the choice of a dialect to serve as the basis for the standard is influenced by a number of considerations: which dialect or variety is spoken by most of the members of a community? If quantitative considerations are not helpful due to the fact that the dialects are distributed equally, could it be more natural to mix the dialects so that the written standard exhibits features from all of the dialects? Or would that make the picture too chaotic and the written standard more difficult to acquire for everyone since it does not correspond perfectly with a single dialect? This choice of a basis for the writing system is one of the sites of ideological interference – here, prestige plays a crucial role. Decisions made with regard to this choice are often not based on what is more natural for most people, but what is most convenient politically for one group within a community. Such is the case with the choice of the Beijing dialect as the basis for literacy education in China (cf. Li 2018). Since the choice of a standard variety is, as is evidenced by its name, a form of *standardization* and external regulation, it is discussed in more detail in the context of Natural Orthography (cf. Section 3.4).

(b) *Technological accessibility* could be interpreted as an external factor, but I argue it is at the same time both an internal and an external factor, a distinction that is based on the perspective taken. Given the choice, a script and writing system should be chosen or devised for which technology is already available – keyboards, typefaces, software, etc. In other words, the choice should not hinder a community from communicating with regard to these technological factors. Jones & Mooney (2017: 31) specifically mention that "non-Unicode characters" should "not be used […] given the ever-present and growing use of word processing" and that "text messaging is often found to be a predominant context for writing, and so only characters that are replicable on mobile phones should be used in these contexts". These technological factors are internal insofar as there exist some scripts (the most extreme example of which is Roman script) for which a lot of technology is available. This, although it has nothing to do with the script *per se*, is intricately linked with the script. The general availability of technological devices and possibilities for a script has, to repeat a sentiment from above, to do with power, hegemony, and politics rather than an inherent suitability of a script for technology.[313] The perfect technological choice, thus, is inherently politically biased. From a different perspective, the technological factor, much like education and economical status mentioned above, is external: even if technology is, in theory, available for a script, this does not mean that it is available in every community. If a community does not have access to the internet let alone computers or other electronic devices, some of the many possibilities of scripts and writing systems which are generally suitable for computers are curtailed. If the technological suitability of a script is counterbalanced by the lack of technological equipment in a community, this might mean a different choice could be more natural: if it does not matter techonologically whether Roman script is chosen, this opens up the possibility to, for example, create a new script with basic shapes that have natural systematic and processing fits. In any case, these considerations must be made and assessed individually for each new writing system to be created.

Let us now turn from sociocultural considerations in the creation of new writing systems to sociocultural factors that are relevant in any existing and established writing system, and with that, any literate community. This is where I return to the second type of the above-mentioned socioculturally relevant type of indexicality, intrasystemic exophoric indexicality. It refers to the fact that certain features of writing can function as indexes that allow not only an entire literate community, but, at a lower level, also individual writers to position and present themselves socially (cf. Spitzmüller 2016).

The cornerstone of exophoric indexicality is grapholinguistic variation. It requires an extensive discussion since it is at the core of conflicts between the sociocultural fit and both the linguistic and processing fits. As was elaborated in other sections of this thesis, variation – both graphetic and graphematic – amplifies the graphetic and graphematic solution spaces, respectively. Graphematically, it reduces transparency and uniformity. This leads to difficulties in the processing of writing systems with a high degree of variation. However, socioculturally, variation is a resource. Only in writing systems in which a number of spellings (or, at a graphetic level, "designs") are possible for a given utterance can writing fully realize its potential as social practice. As Sebba (2007: 32) notes, if writing "is to carry social meaning, then there must be scope for variation". As already established in Section 2.2.3, both licensed and unlicensed variation can only occur in writing systems that are not fully biunique, and – at a graphetic level – to a larger degree in scripts that are more flexible in their visual variations, i.e. have larger graphetic solution spaces, than other scripts. Why is the possibility of variation regarded as socioculturally natural when it is unnatural descriptively and from a processing point of view?

Without graphetic or graphematic variation, it would not be possible to convey additional meaning at these levels of writing, i.e. meaning that goes beyond mere denotation. Imagine a situation in which there exists only one typeface, which is not unthinkable since a few decades ago, when typewriters were heavily used, only one typeface was available, and the typefaces of different models of typewriters were all very similar. There was simply no other typeface available, so producers of a text could not convey additional, non-denotational information about themselves or the text by means of graphetic variation. Entire subbranches of design – in typography, marketing, etc. – would not work without this very variation since they rely on the connotative meaning it potentially evokes. Similarly, at the graphematic level, imagine a wholly biunique writing system in which in graphematic solution spaces for words, there is always

[313] However, one could argue that some features of a script do influence its inherent suitability for technology. For example, the size of a script – defined as the number of basic shapes – was, in the case of Chinese, a challenge for the design of a Chinese typewriter (cf. Mullaney 2017).

just one possible spelling. Variation would be inexistent and with it also the possibility of deviance. Consider the replacement of Spanish <c> or <qu> with <k>, a grapheme that is not part of the native grapheme inventory of Spanish but which is part of the neighboring writing system of Basque and many other European writing systems. This replacement is a practice of mainstream text messaging in Spanish, has its roots in Spanish counterculture and, before coming into use in digital texting, was popular in graffiti during the late 1990s (cf. Sebba 2009: 43). It only works because there is more than one way of representing /k/ in one graphematic module or across graphematic modules. This case is not only an example of variation, but more specifically unlicensed variation. The deviation from the standard carries meaning, and so does the connection that can be established between Spanish and neighboring writing systems such as Basque.

Whether not granting users the possibility to express themselves through variation in writing is unnatural, or just how much variation in a writing system is natural, are, ultimately, philosophical questions that cannot be answered empirically. What I want to argue here is that variation fulfills, among other things, crucial social functions. If, very simplistically, variation vs. non-variation are seen as an absolute dichotomy, then writing systems that allow for variation are more natural than writing systems that do not. As implied above, while a certain degree of variation adds naturalness to the sociocultural fit of writing systems, this is in severe conflict with the linguistic fit, where it results in a decrease of transparency and uniformity, and the processing fit, where this, in consequence, leads to difficulties in reading and spelling.

The “death” of scripts and writing systems is another phenomenon that is interesting from a sociocultural point of view. As Watt (1981: 306) noted, the death of scripts is determined by “markedness” and, more specifically – if his views are reinterpreted in a naturalist framework – cognitive unnaturalness (cf. also Morin 2018: 666). However, I want to argue that while this might hold true for the change of scripts, in the process of which unnatural features are eliminated, it is not true for the death, i.e. the end of existence for scripts (as well as writing systems), as that is determined, predominantly, by sociocultural factors. When speaking of ‘death’, it must be clarified that scripts and writing systems do not cease to exist, they only cease to be used. This is why Houston, Baines & Cooper (2003) speak of “script obsolescence” instead of script death. There must be special circumstances for script obsolescence to occur. Unseth (2005: 30) notes that literate communities do not usually just abandon literacy,[314] but instead switch from one writing system to a different writing system, “usually from a neighboring group”. It is through this switch that the initial script or writing system ceases to be used. Accordingly, the final stages of a script or writing system are reached when there are only a few users left (which was, for example, the case for Nüshu women’s script, Ban Niang Wu, and Dongba) and/or when their use is restricted to very few, and mostly specialized, domains. One example for the latter scenario is the Indic-derived script used to write Hanuóo in the Philippines. Today, it is predominantly used for love songs and courtship. Although this domain is entrenched with cultural value, “it does not seem likely that a script with such a restricted use will survive the encroachment of the Roman alphabet” (Unseth 2005: 30) which is used to write Hanuóo in all other domains.

In line with the situation described in the two theories of language change discussed in Section 1.3.4, socially initiated change of this kind cannot be predicted. Indeed, there is no way of predicting when, for example, a political leader or government will decide that the script of a writing system is changed or forbid the official use of a previously used script (as in the case of Arabic in Azerbaijan, cf. Hatcher 2008; Section 3.2.3). These events can potentially lead to the obsolescence of the replaced or prohibited script. The mentioned symptoms of restricted use for few (and specialized) contexts and a low number of users literate in a script might be indicators of an approaching script obsolescence, but they are ultimately symptoms of unpredictable hu-

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[314] Unseth (2005: 31) mentions a number of cases in which literacy was indeed ‘lost’: Rongorongo script on Easter Island, Indus-valley script in India, and the loss of writing in Greece during the Dorian age.

man behavior instead of reflexes of human physiological or cognitive pressure. While the change of scripts and writing systems can be predicted by the linguistic and processing fits, the sociocultural fit adds a large portion of unpredictability to the mix. Thus, sociocultural naturalness parameters can only point to possibilities of a script or writing system being used, for many of the reasons named above: it is accessible to everyone, it is socioculturally suitable because it conveys belonging or distance from certain groups, etc.

An interesting facet of the sociocultural fit of writing systems that I only mention briefly is the question of how well writing systems cope with depicting reality, and especially how well they reflect certain aspects of a given culture or society. One of those aspects that also has been under linguistic scrutiny is the status of genders, and particularly the status of women in a culture. A striking example of this is the use of the female radical, i.e. the semantic component signaling “female” in the Chinese writing system. It is based on the grapheme <女> *nǚ* ‘woman’. In their analysis, Chin & Burridge (1993: 54) establish that 90% of words that include the female radical “are either semantically negative or convey images of women steeped in damaging stereotypes” and conclude that the Chinese writing system is sexist in its portrayal of women. A demonstrative example is <妇> *fù* ‘wife/married woman’, made up of the female radical and a semantic component meaning ‘to sweep’, giving the impression that a married woman is a “woman who wields the broom” (Chin & Burridge 1993: 64). Other examples include reduplications of the female radical as in <奻> *nuán* ‘quarrel, dispute’, in which it occurs twice, or <姦> *jiān* ‘adultery’, which includes three instances of the radical. It is clear that the structure of these graphemes reflects historical societal beliefs and structures that were predominant at some point in history, and I do not want to get into the specifics of the contemporary problematics of these historic remnants in the modern writing system of Chinese. Instead, these examples highlight that there are a wealth of dimensions to writing, many of which are socioculturally charged to a fundamental degree. For Chinese, Chin & Burridge (1993) point out that there are a number of facets in the entire language – predominantly the lexicon – that they consider sexist, but writing ‘takes the cake’ in that the degree of its sexism is vast and, importantly, independent of the sexism exhibited at the other levels of the language. Writing, thus, can be indexical in ways that are not linked to other levels of language, which highlights that an elaborate study of the written form of languages is a necessity.

Finally, this section cannot end without a mention of *contact phenomena*. From a sociolinguistic perspective, language contact is a central phenomenon, and this is certainly also true for the contact of writing systems. For example, all of Unseth’s (2005) sociolinguistic strategies named above – (1) showing affiliation, (2) distanciation, and (3) participation on a larger scale – only work because communities are aware of each other and of each other’s literacy. It is obvious that existing writing systems often heavily influence the process of literacy development in neighboring communities. This influence highlights the fact that the contact between literate communities, and, crucially, also the contact between non-literate and literate communities, is often characterized by hierarchical structures, and most commonly by an asymmetry of power and prestige (cf. Coulmas 2014). Writing systems never exist in isolation, and in times of globalization and the advent of digital communication, the scope of influences that affect literacy in a given community has only multiplied. A detailed discussion of contact phenomena would go beyond the scope of this thesis, but it should nonetheless be clearly stated that contact phenomena must always be considered as factors that can heavily affect the sociocultural fit of a writing system.

3.4 Natural Orthography

> It is, of course, an open question as to how much, if any, standardization is really required. (Trudgill 2000: 136)

> [...] it may be best to allow a standard to evolve naturally instead of prescribing right from the start how a given language should be written. (Karan 2014: 109)

Orthography is different. As established in Section 2.2.3, unlike the graphetic and the graphematic modules, the orthographic module is optional – writing systems do not need to have it. However, this does not make orthography merely a detached apparatus of rules that is superimposed upon an existing system. As Schmidt (2018) argues, orthography is phenomenologically primary, and graphematics is secondary. This is evident, for example, in the fact that children in prescriptive literate communities, from the outset, learn and aspire to not only write, but to write *correctly*. Any behavior beyond the rules and norms of orthographic standardization always leaves the aftertaste of being a deviation, which means the resources that a writing system offers are – much like Maas (2015) argues – severely curtailed by an orthography. Orthographic norms are not only external but, due to the priority afforded to orthographic regulations in literate communities, become internalized. Disentangling these external and internal norms and their effects on the written output in the context of grapholinguistic research appears almost like an impossible task. What can Natural Orthography as a subbranch of Natural Grapholinguistics achieve? It is clear from the outset that the answer will be very different from what is investigated by Natural Graphetics and Natural Graphematics.

There are two main approaches to Natural Orthography. The first of them is rather static in that it describes the status quo. It analyzes a writing system's orthographic module – i.e. its rules, its exceptions, etc. – and investigates its relationship with, predominantly, the graphematic module, but also the graphetic module. Relations between orthographic rules and the corresponding features of the graphematic module can be treated analogously to graphematic relations between visual units and linguistic units: as signs. The semiotic parameter of transparency, for example, can also be assessed for how the orthographic module fits the graphematic module: how transparent is an orthographic rule with respect to the property of the graphematic module it regulates? The same can be done when orthographic rules pertain to the graphetic module: what is the relation between what the graphetic module naturally "offers" and how the orthographic subjects it to regulation? This first and static approach is important in the evaluation of the descriptive naturalness of an orthography, and the discovery of unnatural features which are mostly part of what I termed *unsystematic orthography*, i.e. rules that are not based in the existing regularities of the writing system (cf. Section 2.2.3). If the threefold distinction in linguistic, processing, and sociocultural fits is taken over from Natural Graphematics, this static descriptive view would be categorized as the linguistic fit of Natural Orthography. The second approach which I will focus on in the following is a rather dynamic approach which, in such a distinction, would be covered – although not neatly – by the sociocultural fit.

The central dynamic aspect investigated by Natural Orthography, I argue, is the behavior of the agents who decide on orthographies. This includes their abstractly defined responsibilities and the guiding maxims that drive their decision-making in the initial establishment of an orthography or the reform of an existing orthography. No matter how internalized and primary orthography becomes in a writing system, to some degree, it always remains an external and artificial intrusion. While orthographies interact with the system and its use, they can only be changed in reforms, and only by authorities who have the right to make such decisions (cf. Section 2.2.3). Orthographies, thus, can be conceptualized as elitist corsets restraining the graphematic and sometimes even graphetic modules. In itself, this gives the impression that orthographies *per se* cannot be natural. Some, however, claim that this is untrue. A point that is often made in favor of orthographies is the fact that when a multitude of spellings is possible for a given word, licensing one spelling as correct can facilitate communication by granting order and thereby avoiding written chaos (cf. Grenoble & Whaley 2006: 130). However, whether this claim is indeed accurate depends crucially on the naturalness of an orthography and on the behavior (the motives and goals) of the authorities who have the power to decide on orthographic matters. The first and more static of these points was described above and concerns the interaction between system and norm: how does the orthographic module interact with the graphematic module and the graphetic module? Is the spelling that is deemed correct even part of the graphematic solution space? A more dynamic, user-oriented question could read: is the correct spelling likely to be used or already in use? It would, for example, be unnatural if an orthography licensed a spelling as correct that is unsystematic, i.e. outside the graphematic solution space and not (yet) part of the system. It would be even more unnatural if said unsystematic spelling was additionally not yet employed by users, who do sometimes make use of spellings that are not established parts of the system (cf. Dürscheid 2000). Since orthographies are not self-regulating systems but external codifications, these mentioned aspects influence how authorities who make orthographic decisions can behave "naturally": they can use the power they have in a reasonable way that benefits as many users of an orthography as possible. Further questions regarding the implementation of an orthography include: "[W]ho does the selecting [of a standard, D.M.]? How long might the process toward standardization take? Is standardization of the writing system a requirement for literacy to take root in a speech community?" (Karan 2014: 107f.). In some cases, as will be discussed below, the most natural action to take is not to impose a standard at all, or at least to postpone its introduction to a later point. In general, two types of relevant tasks performed by "orthographers" at different stages need to be distinguished: (1) establishing an orthography, and (2) changing, i.e. reforming an orthography.

The question of whether a standard is necessary in preliminary stages of a community's acquisition of literacy is discussed by Karan (2014) in the context of the development of writing systems in non-literate communities. She argues for "'slowing down' and allowing a standard to evolve through practice rather than prescription" (Karan 2014: 107) and provides examples to underline how this practice could be reasonable. It has been mentioned before that the creation of a writing system does not equal the creation of an orthography. If the graphematic module of the newly created writing system is not completely uniform and transparent, there will be some variation in the graphematic solution space, variation that – without orthographic regulation – can be exploited. In the context of literacy development, this stage, in which various competing spellings occur simultaneously, is sometimes referred to as *working orthography* (cf. Bauernschmidt 1980; Karan 2014: 108). This is precisely the point at which my criticism of the misuse of the terms *orthography* and *orthography development* that is scattered throughout this thesis becomes most imminent: creating a writing system should indeed, in a first step, only entail creating a writing system, and not an orthography. Thus, what is really done – or what should be done – in this process is *writing system development* (cf. Karan 2014: 109). The predominant use of *orthography development*, however, does reflect reality to some degree, as in literacy programs, standardization is often a high priority. Guiding the whole process is a "'normative' expectation" (Karan 2014: 109) both from people working on creating the writing system and people for whom it is created. Consequently, even in the early stages of these systems, creativity and freedom of spelling are not usually encouraged. Instead, it is unwelcome. As has already been discussed in the context of the orthographic module's function, once prescriptive concepts of literacy have instilled in people a sense of normativity, they themselves prefer not to have a choice, but instead clear and unambiguous rules that tell them how to write. This trend towards standardization is also welcomed top-down by governments who often instruct committees or agencies with the task of creating an orthography, as a written standard allows the production of consistently and uniformly spelled reference works – textbooks for education, dictionaries, etc., which is of course also an economic question (cf. Karan 2014: 110). An orthography brings order to a situation that is, through a normative lens, perceived as chaos.

This mindset is highly influenced by the contemporary relevance of orthographies. As I will show below, writing systems that have existed for long periods did not initially come into existence as standardized systems. These systems, too, existed without orthographies after they were created and developed. With this in mind, it might truly be reasonable to enforce "non-standardization" (Karan 2014: 111) in modern instances of writing system development, which, notably, is not equivalent to a neglect to standardize simply because standardization is not on the agenda of orthography mediators. Instead, it is their deliberate and conscious decision *not to* standardize a system. It is the decision to wait and let a natural play of forces sort out some of the graphematic conflicts which, in the case of an often rushed implementation of an artificial standardization would need to be dealt with arbitrarily, externally, and top-down. Another point that must be considered is that if an orthography is introduced too early, later modifications become a difficult affair. While modifications of a graphematic system occur naturally, modifications of orthographies always constitute *reforms* (cf. Section 2.2.3) and come with an entire machinery of sociopolitical consequences: since an orthography is an external codification, in the case of a reform, this codification needs to be amended. This has major repercussions for a literate community that has grown accustomed to an orthography: one factor that affects the processing fit, for example, is that people who are competent in the superseded orthography have to acquire new rules while simultaneously "unlearning" the outdated rules. A technological factor that can be costly is the update and replacement of material based on the old orthography: dictionaries, textbooks, etc. This all goes to show that deciding on an orthography too early in the development of a writing system means risking the necessity of reforms which entail a number of negative consequences.

Karan (2014: 113) names a few steps that can be followed in order to create a natural orthographic standard:

> Writers' actual, uninhibited writing before being "trained" needs to be analyzed. Deviations from the proposed standard might reveal mother-tongue-speaker intuitions possibly indicating a point of linguistic misanalysis or highlight certain symbolization preferences.

What she describes in this quote strikingly echoes Naturalness Grapholinguistics and its methodology of uncovering naturalness in writing at all levels: the graphetic and the graphematic levels, with respect to the systematic and linguistic, processing, and sociocultural fits. That she phrases it this way further underlines the suitability of Naturalness Theory for the subject of writing. Natural Graphetics and Natural Graphematics can be instrumentalized as auxiliary disciplines of Natural Orthography as their findings can be used to create a standard that is designed in favor of the naturalness that is already inherent in the system – and not against it.

Some literate communities do not value standardization highly. Among them are the communities of Jamaican Creole English and Yucatec Maya. As Brody (2004) has shown, users of the Yucatec Maya writing system tolerate variation in spelling. In fact, a meeting in 1984 that had the purpose of establishing a written standard came under a lot of scrutiny as the public interpreted it as an exclusive enterprise "by linguists, for linguists" (Brody 2004: 155) in which native speaker input was unwelcome. This input is, however, crucial.

Karan's (2014: 119) major argument rests on the fact that "[s]tandardization and the implementation of a reform take time". She highlights this by contrasting the immediate push for standardization in modern creations of writing systems with a number of European writing systems in which a standard developed *naturally,* i.e. over a long span of time and without prescriptive intervention. Elmentaler (2018) outlines major aspects of such a development in his account of the historical graphematics of German. In this process, variation did not pose a problem, and certain factors in the development of the writing system and its use exhibited standardizing tendencies – without, however, being perceived as interfering with the system from the outside. Only after a long development were the German writing system standardized and this standardization externally codified as an orthography. This natural emergence of an orthography differs fundamentally from the immediate standardization of a new writing system that has just been created from scratch.

When the decision to standardize has been made, one of the most complex factors that can "emerge as a contentious and divisive issue" (Jones & Mooney 2017: 7) is the choice of a language variety as a basis for the standard. There are various approaches to this problem. In the (a) *unilectal approach*, a single reference dialect (or variety) is chosen as the basis for an orthography. One advantage of this approach is that – as in the case of Arabic or Chinese – it serves a unifying function and highlights a common identity, and this can prove natural with respect to the sociocultural fit of writing systems. However, speakers of other dialects than the one chosen as the base dialect are put at a disadvantage. They have to adhere to another dialect. If they are not yet familiar with that dialect, they even have to learn it in order to write correctly. In any case, they have to bridge the linguistic distance between the variety they speak and the variety that is written. A unilectal approach could foster social and political tensions as the choice of one dialect could be interpreted as "deliberate favoritism" (Karan 2014: 116). Certain factors can influence the choice of a dialect: for example, a dialect might be chosen because it is spoken in a region in which political power is most highly concentrated. Furthermore, the number of speakers of a dialect might also be decisive. A third factor is prestige, with the most prestigious dialect being the most likely candidate for a standard. If authorities who design an orthography indeed proceed with the unilectal approach, it is paramount to make "clear to all [users of an orthography, D.M.] that adherence to a written standard allows text to be read with various dialect pronunciations" (Karan 2014: 116). This could increase the acceptance of the unilectal orthography by speakers of other dialects.

In the (b) *dialectal approach*, multiple orthographies are established based on multiple dialects. This can be done when the linguistic distance between the dialects of a language is too great. Because of the sociocultural indexicality of writing, the existence of distinct orthographies conveys social fragmentation. This, of course, can also be the desired outcome in cases in which groups wish to distance themselves from each other, but it is detrimental in cases in which the unity of a language should be highlighted by its written form. Note that the dialectal approach is seldom the one adhered to in practice (cf. Jones & Mooney 2017: 8).

In the (c) *multi(dia)lectal*[315] *approach*, features from various dialects are combined in a single orthography. This can help "foster a common identity for the speech community at large" (Jones & Mooney 2017: 8f.). However, choosing which features of which dialects to include in the orthography is no straightforward matter, as "the question of how best to accommodate different varieties within a single orthography leads directly to issues of power and authority" (Sebba 2007: 112). Linguistically, the inclusion of features from different varieties will likely result in situations of over- and underrepresentation: when a distinctive feature of one dialect that is not distinctive in another dialect is included in the orthography, for example, this leads to superfluous overrepresentation for the latter dialect and intervenes with both the linguistic and processing fits (cf. Karan 2014: 117).

A final option is the (d) *common-core approach* in which an orthography is based on an "artificial"[316] dialect which is created by means of a historical reconstruction of the common core of a language's various varieties. This approach has had very limited success. It is not recommended since with respect to the sociocultural naturalness parameter of *accessibility*, it would not be directly accessible to any speaker of any of the varieties, as it is not directly based on any one of them (cf. Karan 2014: 117f.; Jones & Mooney 2017: 9). The disadvantages for all members of the language outweigh the sociocultural benefits of this approach, i.e. that no single dialect is given a privileged status.

When it comes to the choice of one dialects or multiple dialects as a basis for an orthography, it is paramount for the authority in charge to convey clearly to users that the (written)

[315] Various terms refer to this approach. While Jones & Mooney (2017: 8) call it *multilectal*, Karan (2014: 117) calls it *multidialectal*.

[316] The dialect would be artificial since it is created artificially. However, it contains and combines features from the existing dialects or historical predecessors of those dialects and thus exhibits natural features. Such an artificial dialect is thus comparable to writing: it is artificial, but it contains natural features.

standard variety is an "additional variety and that it does not aim to replace spoken dialects" (Jones & Mooney 2017: 9). Users must be reassured that the dialects that were not chosen as the standard still have an equal footing. This, however, might be perceived as insincere when one dialect is chosen since the orthography based on it elevates its status to that of a standard, thereby raising its prestige. This automatically gives the impression that the other dialects are of lower prestige. It is, thus, debatable whether all varieties in such a situation are truly equal.

Note, also, that all of the approaches listed above are restricted to phonographic writing systems or phonographic elements in writing systems. Morphographic systems pose different challenges. In principle, for example, in Chinese, the "writing system permits the imposition of different phonological systems onto the syntax and the lexicon of the standard written language" (Handel 2013: 24) since, holistically, Chinese graphemes refer to morphemes. Whether the phonological "clues" provided by the phonological components of graphemes are useful for other "dialects" than Mandarin is a reasonable question, however (see below). In the creation of new writing systems and the establishment of a standard, the possibility of creating a morphographic system is often quickly discarded in favor of an alphabetic (or, also seldom, syllabic) system, as "it is argued that morphographic systems are inferior to phonographic ones" (Jones & Mooney 2017: 13). This, however, cannot be regarded as an absolute statement, as the suitability of an entire type of writing system is crucially dependent on the properties of the language that it is intended for (cf. Section 3.3.1.1 and also the discussion in Section 3.5). With respect to morphography, it is also noteworthy that predominantly phonographic systems can, by virtue of their orthography, include morphographic elements. Modern accounts argue, for example, that morphography plays a central role in the alphabetic writing system of German (cf. Schmidt 2018).

The following remarks are not concerned with the establishment of a new orthography for writing systems in which there previously existed no standard, but the change of orthography, i.e. orthography reforms.

An example of an orthographic reform that highlights how the orthographic module can act unnaturally upon the graphematic module comes from Chinese and the changes subsumed under the heading of *character simplification* (cf. Hu 2015). Handel (2013: 21) comes to the devastating conclusion that "today's simplified character script cannot be categorized as an effective reform by any reasonable metric – it is only simpler in the crudest of senses". In 1956 and 1964, in the People's Republic of China, a two-staged simplification of the Chinese writing system was undertaken. Its goal was to make the writing system easier to learn and use. Simply put, reducing the number of strokes in characters was believed to make them easier to learn and memorize, which, on a grand scale, was thought to result in higher literacy rates (cf. Handel 2013: 39). Handel reconstructs in detail how the simplification does not suit the structural properties of the Chinese writing system. To the contrary, in many cases, the simplification opacified the system's natural features and "increased systemic complexity" (Handel 2013: 43). I want to reproduce only some of his numerous examples to underscore how orthographic regulation can be unnatural when it interferes negatively with the graphematic module.

The following examples pertain to Chinese graphemes of the *xíngshēng* 形聲 group (cf. Gong 2006: 47f.) which are composed of both a semantic component and a phonological component (cf. Section 2.2.2.1) and represent the most common type of grapheme in Chinese. Take the example of traditional <讓> *ràng* 'let, make' which was simplified as <让>. What Handel (2013: 43f.) calls *incomplete replacement of phonetic elements* concerns the failure to analogously simplify other (admittedly, low-frequency) graphemes which include the same phonetic element <襄> *xiāng* 'assist'. Aside from a number of other inconsistencies regarding the phonological components of graphemes, Handel (2013: 45) also mentions positional problems with radical simplification: for example, the grapheme <言> *yán* 'speech', as an independent grapheme, was not simplified. When used as a semantic component, however, it was, as <訁 > became <讠 >. Accordingly, <語> *yǔ* 'language' became <语>, <課> *kè* 'course' became <课>. When positioned at the bottom of a basic shape, however, the semantic component was not simplified:

<警> *jǐng* ‘warn’ stayed the same, as did <譬> *pì* ‘example’. Handel (2013: 45) concludes that “what in the traditional system is a single element [...] with consistent semantics has become two distinct elements [...], both of which must be learned, and both of which occur with the same functional role; the choice is determined positionally”. What Handel does admit, with respect to this example, is that this type of complex positional allography (cf. Section 2.2.2.2) already existed in the writing system of Chinese. Accordingly, he argues that these newly introduced instances of allography “serve to exacerbate existing patterns of inconsistency rather than introducing new types of inconsistency” (Handel 2013: 45). This is a crucial point for the conception of a Natural Orthography, as I argue this is precisely what orthographic regulations and reforms should not do: they should neither introduce new inconsistencies nor increase existing ones. What orthographies should instead do (see above for unstandardized writing systems) is curb existing inconsistencies. Simply put, if it is necessary to interfere with a naturally grown writing system at all, then, for this interference to be justified, it should at least function to decrease unnaturalness in the graphetic and graphematic modules.

One of the questions Handel asks is whether a writing system with an internal structure such as Chinese could even be (or have been) reasonably simplified while keeping its structure and its type, i.e. not being supplanted by a syllabic or segmentally phonographic writing system. He affirms this and proposes a number of steps that could be taken to achieve this. First, the consistency of the phonological components should be increased. This could be done by agreeing on one phonological component for each of the phonotactically legal phonological syllables of Modern Standard Mandarin, of which there are approximately 400 when the four tones are disregarded. For comparison, at the moment, there exist about 800 phonological components in the Chinese writing system. Since many of the 400 possible phonological syllables serve as the phonological representation of multiple morphemes simultaneously, homophonous morphemes should be disambiguated by semantic components. The 200 existing semantic components of the existing system should be regularized, and importantly, their positions should be fixed in that they should only occur on top or to the left of phonological components.

I have produced a simplistic rendering of Handel’s sophisticated suggestions here, but it suffices to highlight that in sum, his proposed steps would result in a “highly transparent” (Handel 2013: 52) system in the sense of transparency discussed in Section 3.3.1.4, with the transparency of the subsegmental components rendering it positionally and compositionally transparent as well. What would probably happen if a reform were to adhere to these suggestions is that orthographic regulations would operate top-down, alter the graphematic module, and increase the linguistic fit as well as – quite possibly – the processing fit.[317] Note that Handel (2013: 54) does not call his suggestion a simplification, but rather a *regularization*. It is noteworthy that due to naturalness conflicts, other aspects which were taken into account in the actual simplification of Chinese graphemes must be neglected in such a regularization: for example, as Handel abandons the practice of stroke reduction altogether, the question of visual complexity and, in general, graphetic naturalness is not touched upon by his suggested regularization. Furthermore, the proposal of a standardized set of 400 phonological components which are based on the phonological syllables of Modern Standard Mandarin “would be offset to an unknown degree by a loss of pan-dialectic applicability of the script” (Handel 2013: 56). Thus, with such unidialectal phonological components, naturalness on the sociocultural parameter of accessibility decreases. This emphasizes that any orthographic regulation or reform must set priorities and decide which competing forces in a naturalness conflict are to be supported and which are simultaneously neglected.

The graphetic module, too, is subject to orthographic regulation. As Kolers (1983: 383f.) remarks, “[it] is commonplace to worry about the rules of orthography as they affect reading,

[317] Handel (2013) puts forward his suggestions against the backdrop of modern psycholinguistic research and underlines that his proposed changes highlight the features of the Chinese writing system that have been found to facilitate processing.

and many nations alter the spelling of words to bring spelling into line with current pronunciation", and asks whether, similarly, "the actual formation of characters can be put to principled test". Strikingly, orthographic regulation is much more uncommon in the graphetic module. This is probably because graphetics is visible, it is tangible, unlike graphematic relations which are somewhat "invisible" since they are abstract and also materialized by graphetics. Alterations of the graphetic module might, thus, be interpreted as more invasive since they actually change the visual appearance of writing. Also, similar to how common orthographic reforms require updates of dictionaries, textbooks, etc., orthographic reforms that interfere with graphetics would require an adjustment of all technology suited for a given script. Yet, there exist ways in which graphetics is orthographically regulated. To exemplify this, I want to briefly name three examples. The first one stems, again, from Chinese. In Chinese, the stroke order, i.e. the order in which the elementary forms of basic shapes are produced, is subject to orthographic regulation, which is odd from the perspective of most other writing systems in which the order of stroke production is free. These rules in Chinese are said to have their origins in the production process, as "[s]troke order rules have been distilled from Chinese handwriting going back thousands of years", with the earliest evidence going back as far as 520 B.C. (Zhang 2014: 424). This situation is strikingly reminiscent of morphonological rules assumed in NP which still have a phonetic motivation (cf. Section 1.2.2.1): stroke order in Chinese, too, has developed into a rule, which, however, still exhibits a natural productionally graphetic motivation. However, unlike morphonological rules, this stroke order rule is not necessary for the production of grammatical utterances, where "grammaticality" can be reconceptualized as "legibility". The stroke order rule is located at a different level, the orthographic level. What is the use of such a regulation of the production sequence? Zhang (2014: 424, emphasis in original) points out that it "contributes to the correct, fast and aesthetic production of *hanzi*". As such, it has become a central part of *hanzi* instruction. Furthermore, it is most commonly used as an index key in Chinese dictionaries, which makes knowledge of it necessary for operating with dictionaries. In Section 3.2.2.2, natural processes of handwriting were identified in the form of the *grammar of action* (Goodnow & Levine 1973). Is the orthographically prescribed stroke order sequence in Chinese similarly natural with respect to the processing fit? Zhang (2014: 424f., emphasis in original) mentions evidence from neuropsychological studies that implies this:

> Research has demonstrated that enhanced performance was observed in different cognitive tasks when *hanzi* was presented as a sequence of strokes/radicals consistent with the standard writing sequence rather than in a random order [...]. The active role of stroke order in *hanzi* processing has been established as a motor schema, stored as part of the representation of *hanzi* in memory, and also as an effective aid in retrieving relevant information about *hanzi* from memory [...].

I discuss this example in order to mention at least one instance of an orthographic regulation that, while it does not introduce naturalness to the graphetic module, at least enforces the naturalness that is already evident in it rather than imposes unnaturalness on it. By regulating the stroke order that has been found to aid processing, orthography makes it binding for, as mentioned, dictionaries and instruction, i.e. textbooks, teaching material, etc. While it is expected that the prescribed stroke order might evolve naturally in children during writing acquisition, its status as an orthographic rule makes sure that it indeed does. For CSL learners, i.e. learners who acquire Chinese as a second language, the regulated stroke order is relevant, too. While they are commonly unfamiliar with the concept of a regulated order of elementary forms in production, they, too, adhere to implicit and internalized sequences of production. What can be evidenced in studies is that these internalized sequences taken from their L1WS interfere with the orthographically regulated sequence in Chinese, which leads to production errors (cf. Zhang 2014). This points to the possibility that while there is a universally natural sequence of production, there additionally exist system-specifically natural sequences of production that have been established through users' experience with a given writing system.

A second example of orthographic interference with the graphetic module is the addition of a basic shape to the version of Roman script used in the German writing system. In 2017, the

Council for German Orthography added an uppercase version of |ß|: |ẞ|. This inclusion has consequences for the graphematic module, as it is now possible, when writing in all caps, to use <ẞ> instead of the alternative <SS>. One of the graphetic consequences of this addition is the shift of graphetic solution spaces, as the two lowercase and uppercase basic shapes look very similar. Additionally, the similarity between |ẞ| and |B| strikes the eye. Consequently, a number of reactions in the media harshly criticized that the added basic shape looks too much like the existing lowercase basic shape or like |B|.[318] It is interesting that what seems to concern people most in the discussion of this addition is the graphetic aspect. The graphematic consequences of this minor orthographic change were not discussed as often, although its general usefulness was questioned by many.

A third example concerns the design of digitally produced text. It is not uncommon for teachers both at school and university to give out guidelines for the design of papers which students hand in. These guidelines operate on a local level which could be called the micro-level: they are often specific to a given person (as an orthographic authority) or institution (such as a university department), a given context (such as a class), and a specific task (such as the design of research papers or theses). How strictly deviations from these norms are sanctioned depends on the orthographic authority in charge. Some might sanction deviations strictly, announcing not to grade or even read papers that do not obey the rules. Consider, in this context, Figure 49 for a demonstrative example which humoristically plays with the concept of orthographic power. The so-called house rules of different publishers or publications such as newspapers also represent a type of micro-level orthographies (cf. Schimmel-Fijalkowytsch 2018: Chapter 7). While the rules named above are explicit, other orthographic regulations of the graphetic module might remain implicit: in a study of the online discourses surrounding the typeface Comic Sans, I cited an example from a person who identified themselves as HR manager and claimed they would immediately throw out any CVs in which Comic Sans was used (cf. Meletis in press b). Similar to ascriptions that are based on orthographic errors (see below), people tend to ascribe certain features such as informality, childishness, etc. to this typeface, and in turn, to the person choosing to use this typeface. Whether implicit rules of this kind are indeed part of the orthographic module, which was defined as being externally codified and binding, must remain a matter of future discussion. The example of Comic Sans definitely underlines the fact that the countless choices that licensed graphetic variation offers – e.g. in the form of thousands of typefaces to choose from – are not necessarily free choices, but choices constrained by the fact that they are indexical and subject to implicit rules and possibly even consequences that ensue if said rules are not obeyed.

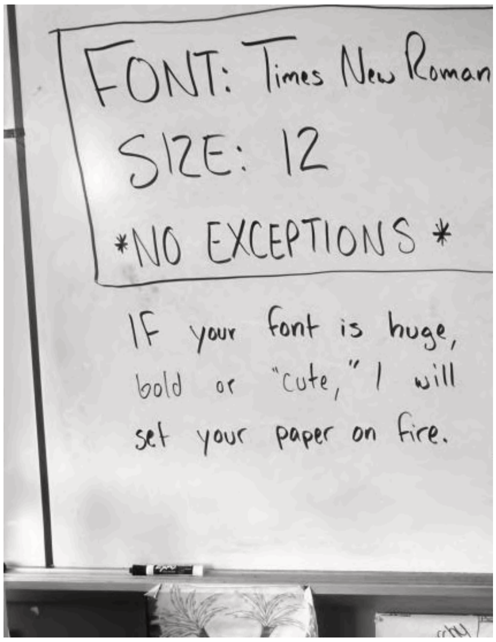

Figure 49: Threat of sanctions for violations of graphetic rules, from: https://i.pinimg.com/originals/86/5c/9a/865c9a6a72f44777eb4eedad9a3ee045.png (February 9th, 2019)

These diverse examples show that there are many ways in which the orthographic module can interact with the graphetic and graphematic modules. In the following, I want to elaborate on how an orthography can deal with variation.

[318] Cf. the criticisms by Andreas Platthaus (published June 30th, 2017) in the *Frankfurter Allgemeine*: http://www.faz.net/-gqz-8zbt2 (November 21st, 2018) or by Cornelia Geißler (published June 29th, 2017) in the *Berliner Zeitung*: https://www.berliner-zeitung.de/kultur/neureglung-rat-fuer-deutsche-rechtschreibung-fuehrt-grosses-ss-ein-27883300 (January 24th, 2019).

One of the features of orthographies presented in Section 2.2.3 is their small degree of variability. While the graphematic solution space might offer countless possibilities for writing a specific utterance, orthography curtails these possibilities. In the discussion of the sociocultural fit above, it was established that a certain degree of possible variation is natural for a given writing system. However, it is an altogether different question just how much of this variation is actually orthographically licensed. The smaller the graphematic solution space, the smaller (usually) the divide between graphematics and orthography, since in that case, the orthographic module merely codifies as orthographically correct the (sometimes sole) spelling that is licensed graphematically. When the graphematic solution space is large, however, the divide between what is possible graphematically and what is licensed orthographically becomes quite remarkable: in that case, there is a large degree of possible variation, most of which, however, is not orthographically licensed and is thus referred to as *unlicensed variation* (cf. Sebba 2007: 30). In some cases, more than one spelling from inside the graphematic solution space is orthographically licensed. It is because of these cases that an orthography exhibits a certain degree of variability. In German, for example, it is presently allowed to spell the word for *typography* as <Typographie> or <Typografie>. Both are correct, which makes this an instance of *licensed variation*. As established in Section 3.3.3, a certain degree of graphetic and graphematic variation is necessary for sociocultural indexicality to even be possible. The question is, now, which *type* of variation is more indexical: licensed or unlicensed variation? In many cases – such as <k> used in Spanish or <x> as in <*demnäxt> (instead of <demnächst>) 'soon' used in German fanzines (cf. Androutsopoulos 2000) – unlicensed variants carry more indexical meaning. Licensed variants, too, might transport some information such as modern vs. old-fashioned (where <Typografie> is more modern and <Typographie> is more old-fashioned), but they are not charged with connotations to the same degree as unlicensed variants.

What applied to the sociocultural fit of writing systems in general also applies to their orthographic module: the needs and wishes of the members in a literate community should be – as best as possible – met. Interestingly, in the case of orthographies, what users appear to want is not variation, but clear and unambiguous rules. Conscious violations of rules and the use of unlicensed variation is one thing, but licensed variation seems to be undesirable to users as it not only makes choices possible but it *requires* choices. Writers of German, as long as they are aware of the options, *must* choose whether to write <Typographie> or <Typografie>, and they do not appreciate these choices (cf. Nerius 2007: 39). An interesting development in this context is the establishment of recommendations by the Duden. The Duden is a dictionary for German and, until an orthography reform in 1996, represented the prescriptive source for German orthography. Now, however, it merely documents German orthography the way it has been decided on by the *Council for German Orthography*. In 2006, when the 24th edition of the Duden was published, so-called recommendations were introduced. In cases of licensed variation, the Duden started recommending one of the possible spellings: in the above-mentioned example, <Typografie> is the recommended spelling (cf. Duden 2017: 15; 1129). These recommendations are supposed to increase the usefulness and usability of the Duden following the orthography reform of 1996 which left users in want of clarity and orientation.[319] In the Duden (2017: 14, my translation), these recommendations are justified as follows: "the recommendations [...] shall make possible a correct and consistent orthography for all those who wish for one and do not want to make their own decisions in the choice of variants".[320] Three factors are highlighted as a basis for the Duden recommendations, and they somewhat resemble the guiding principles of the *Council for German Orthography* discussed below: (1) the actual usage of written language is observed by Duden's editorial team, (2) the needs of readers which call for an optimal comprehensibility of texts shall be met, and (3) the needs of the writers, too, who

[319] Cf. original statements given in 2006 by a spokesman of the publishing house who issues the Duden: https://derstandard.at/2477707/Duden-gibt-erstmals-Empfehlungen (December 6th, 2018).

[320] „Die Empehlungen [...] sollen all denen eine richtige und einheitliche Rechtschreibung ermöglichen, die dies wünschen und keine eigenen Entscheidungen bei der Variantenauswahl treffen möchten."

wish for an easy operability of the orthography, shall be satisfied (cf. Duden 2017: 15). Interestingly, the latter two of these three factors are often in conflict, which the Duden actively acknowledges. However, in observing the actual usage, the editorial team can determine, for given spellings, which one of the two principles is dominant at a given time.

With respect to both the observation of the actual usage of a writing system and the decision to postpone the implementation of a standard, I want to mention an example which deals with the depiction of the reality of life in writing, and specifically the depiction of genders, a question that was already introduced in the context of the sociocultural fit of Chinese (cf. Section 3.3.3). A topic recently discussed by the *Council for German Orthography* is the question of a preferred way of writing 'genderwise' appropriately, a practice for which in German, a verb has been coined: *gendern* 'speaking/writing genderwise correctly'. In the last couple of decades, different strategies of avoiding the generic masculine – both in the singular and in the plural – have developed in German, among them the so-called internal I (German *Binnen-I*) as in *LehrerInnen* 'male teachers and female teachers' and writing out both forms as in *Lehrerinnen und Lehrer* 'female teachers and male teachers'. Additionally, the use of elements such as an underline <_> or an asterisk <*> as in *Lehrer_innen* and *Lehrer*innen* has become increasingly popular among people wishing to write in a socially more inclusive way. These two latter strategies aim also to include other genders, e.g. people from the trans* community, and people who generally do not identify with and do not feel included by either male and female forms. To observe and study the topic, the *Council for German Orthography* has initiated a task force/research group entitled *Geschlechtergerechte Schreibung* 'genderwise correct spelling' which, in November 2018, presented a report in which it discloses that it decided not to codify any of the existing strategies as correct (cf. Rechtschreibrat 2018). It justifies this on the grounds that these above-mentioned practices of writing in a genderwise sensitive way constitute a rather new phenomenon and as such, are still being actively negotiated by literate German language communities. This becomes obvious in corpus analyses illuminating the phenomenon. On these grounds, the Council also opts not to give a clear recommendation of which strategy should be preferred, claiming it does not want to interfere with the 'natural' way of how the literate community sorts this out itself. What the task force does formulate is a slate of very general guiding maxims that should be followed when attempting to produce texts in a genderwise appropriate way (cf. Rechtschreibrat 2018: 8).

From the perspective of the sociocultural naturalness of orthography, the Council's behavior, specifically the decision not to codify or recommend a strategy, can be read in two ways: on the one hand, it can be interpreted as a sensible decision of "'slowing down' and allowing a standard to evolve through practice rather than prescription" (Karan 2014: 107).[321] On the other hand, it can be interpreted as the opposite: the failure to prescribe a standard, which equals, in this case, a failure to take a clear stand. This argument is based on the fact that language not only reflects but shapes reality. The multitude of strategies available for writing genderwise appropriately produce an unclear situation for users who prefer unambiguous rules (see above) and might result in an avoidance of writing genderwise appropriately altogether. Such a situation is also a fertile ground for skeptics and opponents,[322] whose negative attitudes, certainly

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[321] This reading of the Council's decision is advocated in an article by Hannah Lühmann who claims that with respect to this issue, the Council puts its trust in the 'natural development of language' and invites the people who speak and write German to negotiate the issue themselves, cf. https://www.welt.de/kultur/plus183982304/Drittes-Geschlecht-Gendern-Vertrauen-wir-der-natuerlichen-Sprachentwicklung.html (March 13th, 2019).

[322] On March 6th, 2019, the *Verein Deutsche Sprache* (VDS), a union which counts over 36,000 members and is invested in the preservation of German as a language of culture, economy, and academia, presented an appeal titled *Schluss mit dem Gender-Unfug!* (roughly translated 'An end to gender nonsense!') which, in essence, is a plea to resist the strategies of speaking and writing genderwise correctly, cf. https://vds-ev.de/gegenwartsdeutsch/gendersprache/gendersprache-unterschriften/schluss-mit-dem-gender-unfug/# (March 13th, 2019). Unsurprisingly, this appeal has reinvigorated the public and medial

not necessarily, but often, correlate with political views and agendas. The Council has the authority to license a standard, and the fact that it chooses not to exercise this authority, in this case, might be interpreted as a failure to fulfill an important societal duty. It is questionable, however, whether it is actually the duty of a descriptively oriented commission to decide on such critical societal questions that undoubtedly go beyond language policy. In the end, it must be noted that the Council at no point argued against writing genderwise appropriately. It just has yet to argue for a 'correct' way of doing it.

With respect to a community's wishes, which prove central for an evaluation of the naturalness of an orthography, I want to mention a series of interviews I conducted with the aim of investigating people's attitudes towards orthography.[323] One of the findings was that all of the participants perceived the process of writing – as well as written products, i.e. texts – as inseparable from orthography. This normativity of writing appears to be so internalized that one interviewee even stated: "Every time that I'm writing somewhere, I'm writing, and *therefore* it has to be correct because otherwise, I could just leave it"[324] (my emphasis). "Therefore", here, refers to the process of writing. This participant established a causal link between the process of writing and the fact that the product of writing needs to be correct. Writing, as a process, is thus implicitly interpreted as "writing *correctly*", which corresponds with the view that orthography is phenomenologically primary to graphematics (see above). Anything that deviates from the norm is regarded as incorrect. With respect to deviations, it was interesting to observe that the participants appeared to exhibit the skill of making fine-grained distinctions between errors and mistakes (for the difference, cf. Section 1.3.3). Interestingly, their attitudes towards these types of deviances were different: mistakes, mostly in the form of 'typos', were scrutinized more critically than errors, which are actual problems with orthographic competence rather than performance. A number of participants argued that a message full of typos gives the impression that the producer did not take their time to reread the message to eliminate the "obvious" mistakes. Since mistakes are a matter of performance, producers should be able to self-correct. If they fail to do so, this is often interpreted as a lack of effort, and in consequence, a lack of respect for the addressee. Another distinction the participants perceived was the distinction between unconscious errors and the conscious use of unlicensed variation. Choices such as the disregard for capitalization in German and the omission of punctuation were frequently named as examples of conscious deviations. When asked about actual errors, which are a matter of competence, and people who regularly make them, participants were eager to deny that they make any ascriptions based on these mistakes. However, the answers they gave frequently contradicted this. One participant noted: "[...] usually I value when people can spell correctly because if they can't, that makes their IQ sink in my head". The passive construction in this formulation reveals that ascriptions are possibly made involuntarily. Rationally, participants argued, there is no reason to correlate orthographic errors with low intelligence or even a low level of education, for example. This was emphasized by all participants. Yet, ascriptions are made, and while they may be involuntary, they are conscious. This points to an aspect

discourses surrounding the topic, with one side supporting the VDS's resistance and the other arguing that its views are outdated.

[323] In May and June 2018, I conducted 14 interviews with eight female and six male participants aged 19 to 29. These semi-structured interviews were part of a larger research project that had at its core the analysis of the depreciative public correction of others' orthographic mistakes on the internet, a practice I termed *orthographic shaming*. Actors who engage in this behavior are commonly referred to as *grammar* or *spelling Nazis* (cf. Bahlo, Becker & Steckbauer 2016; Švelch & Sherman 2018). A core part of the project was a collection and analysis of German instances of orthographic shaming on Facebook. In the 14 interviews, participants' attitudes towards this behavior were of interest, and participants were, among other things, given an example of orthographic shaming that they reacted to. A number of interview questions focused on general attitudes towards orthography, including: *What is your view on the topic of orthography? What role does it play in your life? Who should be allowed to decide on orthographic matters? What is your opinion on orthography reforms? Should everyone have a say in them? How do you assess your own orthographic competence?*

[324] The interviews were conducted in German. My translations here are as literal as possible.

that appears to be central in the assessment of the naturalness of orthography: an orthography's accessibility. Orthographic errors or mistakes are not sanctioned by law, but they are socially sanctioned both in the professional realm and in the private realm. Consider CVs including errors or mistakes, but also erroneous messages on online dating platforms or dating apps, which, if the addressee is orthographically competent and also ascribes personality traits based on orthographic competence, are potential reasons to disregard someone as a potential employee or potential partner.

The possible sanctions for deviances from an orthographic standard highlight that it is important for everyone in a literate community to have comparable access to an orthography. In order to make that possible, the orthography should not be too unnatural. In the present context, this means that the orthographic module should not increase unnaturalness in the graphetic and graphematic modules, but, instead, should attempt to curb unnaturalness in a way such as Handel's (2013) suggestion for a regularization of the Chinese writing system (see above) would have done.

The question to which the participants in my study gave the most elaborate answers focused on authorities who decide on orthographies and orthography reforms. This echoes the fact that this topic is emotionally charged (cf. Johnson 2005). Interestingly, none of the participants stated that they wished to be included in the orthographic decision-making process. A number of them expressed ideas such as popular referenda in which the public could be given the possibility to participate in decision-making, or committees in which members of different groups, among them students and teachers, should work together on establishing an orthography. Interestingly, when the question circled back to who should have the final say in the decision on orthographies, all participants agreed that only experts should be authorized to make decisions. In most cases, this was justified with the fact that letting "normal people" have a final say would mean running the risk of having the orthography turn out chaotic due to irrational decisions lacking a scientific basis. However, according to the participants, what the experts should do is observe and investigate the use of the writing system and base their orthographic decisions on the observations they make. Strikingly, this also includes bringing to a halt developments of written language that the participants judged as unfavorable, including certain facets of youth language. In this respect, the participants uttered conservative views regarding, for example, the inclusion of new words to the dictionary. They appeared to have adopted a more conservative stance on change than the Duden who adds new words in every updated edition of its dictionary: in 2017, <Selfie> 'selfie', <Filterblase> 'filter bubble', <Cyberkrieg> 'cyber war', and <Emoji> 'emoji' were among these new words (Duden 2017). Preserving the current standard, which is seen as prestigious, is among the tasks that the participants considered as central for authorities of linguistic policy.

Inversely, participants argued that orthographic authorities should also have the users' needs in mind, which was most evident in the answers which focused on the attitudes on orthography reforms. Thus, an orthography should only be changed in ways that respond to the users' needs. Here, processing needs were foregrounded, i.e. orthography reforms should make an orthography easier to use. Some of the participants alluded to a central naturalness conflict when they urged caution with respect to the balance between writers' and readers' needs, ultimately siding more with the readers: spellings should not become too easy to write since that would possibly make them harder to read.

Similar to the challenges the Duden presents itself in the formulation of its recommended spellings (see above), the conflicting duties ascribed to authorities who have to decide on matters of orthography very clearly highlight the impossible task of fulfilling all needs simultaneously. The highly intricate task they face, at the core, is shaping the writing system, particularly in a way that improves upon it rather than damages it. This means that orthographic authorities need not only identify naturalness conflicts in a vein similar to how this present study does it, but they ultimately must make prescriptive decisions based on their analysis. This, understandably, puts a lot of weight on their shoulders, and the fact that there always exist at least some negative reactions to almost every orthography reform (or initial implementation of an orthography following the creation of a new writing system) reflects how a part of the public – as well as specific stakeholders such as the media, politics, and academia – always finds some faults with the decisions made. Not everyone can be pleased by decisions in orthographic matters. And in the case of orthography, unlike in graphetics and graphematics, there are specific actors that are held responsible for their actions by the larger literate community.

3.5 Summary and discussion

The present study attempted to highlight the natural features of and in writing by applying to writing the principles of Naturalness Theory. Thereby, it proved that the construction of a theory of writing is feasible. In doing so, it brought forth a number of diverse outputs:

- a re-evaluation of Naturalness Theory, showing that it is a suitable theory for writing but also that it is a coherent theory of language, which, however, can be reasonably modified in certain respects,
- a re-evaluation of theoretical grapholinguistics which aims at embedding a descriptive model of the structure of writing systems and the core units and concepts it entails into a theory that not only describes but explains the nature of writing,
- a meta-study on grapholinguistic research, showcasing different subfields of the discipline, the state of the discipline, and its many remaining desiderata which reveal themselves clearly in the lack of research on a number of aspects of a Natural Grapholinguistics,
- most importantly, a systematic analysis of the structural and psycholinguistic make-up of writing systems and their processing, and, on the basis of that,
- a Natural Grapholinguistics, a proposed theory of writing, complete with a blueprint for comparisons of writing systems, a *tertium comparationis*.

Although they overlap considerably, these points all prove to be separate strands of a larger discussion, and I will treat them one by one in the following subsections. Additionally, I will highlight the practical applications that the findings might allow.

3.5.1 Re-evaluation of Naturalness Theory

Naturalness Theory *per se* was not the focus of the present study. Instead, the status quo of the existing theory served as a backdrop for the establishment of a theory of writing. Thus, attaining a picture of the possible modifications of the theory which are outlined below was not the main goal of the study, but a side effect. As this study's subject was neither phonology nor morphology, the modifications of Naturalness Theory addressed here are not concerned with its specific subbranches, but with the abstract core of the theory.

In the course of this study, it became clear that the core principles of Naturalness Theory are not only elegantly simple and sound but also that they are attractive for other domains. This has never been obvious since the initial subbranches of NP and NM which established the theory are not part of contemporary mainstream linguistics – and have never quite been. The application of the theory to the subject of writing highlighted the adaptability and versatility of Naturalness Theory, which is arguably a trait speaking in favor of any theory. Also, the application to writing underlined that the theory is more coherent than its separate subbranches with their respective foundations might insinuate. On the one hand, since writing is a distinct modality with its own and specific materiality, which is descriptively captured by the graphetic module, the physiological motivations from *Natural Phonology* (NP) which originally concern the materiality of spoken language can be transferred to *Natural Graphetics*. Due to the differences in medium (acoustic vs. visual), what is natural in the context of writing is not what is easily spoken and heard, but what is easily written and read. On the other hand, the cognitive motivations which serve as a basis for *Natural Morphology* (NM) prove useful for a naturalist treatment of writing systems. Writing systems, like the morphological subsystem of language, can be conceptualized as semiotic systems, which allows reconceptualizing and operationalizing the semiotic naturalness parameters elaborated in NM for a *Natural Graphematics*. The core assumption remains the same: what is descriptively natural in a semiotic sense is more easily processed cognitively and is, thus, more 'natural' in its reading 'easier for the brain'. This study showed, however, that this assumption is not always straightforwardly true.

Sparked by the diverse methods and epistemological interests of NP and NM, some scholars emphasized the distinctiveness of the physiological vs. cognitive foundations of what is phonologically natural vs. what is morphologically natural and instrumentalized the differences as support for keeping these two fairly separate scholarly traditions of NP and NM apart (cf. Section 1.2.3.2). However, the fact that writing can combine both physiological and cognitive foundations serves as evidence which proves that Naturalness Theory is capable of handling and explaining the existence of both the material and the functional aspects of language simultaneously. This justifies the proposal of *Natural Graphetics* and *Natural Graphematics* as subbranches of a larger, coherent enterprise termed *Natural Grapholinguistics*.

Aside from physiology and cognition, the third type of extralinguistic explanatory foundation that was postulated as relevant in Naturalness Theory (especially NM) but whose systematic treatment was ultimately 'postponed' indefinitely is the sociopragmatic foundation. Indeed, not only physiology and cognition put constraints on language – and writing –, but also its seminal function of enabling communication, which itself is constrained by social and cultural factors. Examples of lenitions and fortitions (cf. Section 1.2.2.1) which are not based in physiology, but the sociopragmatics of communication, can be observed abundantly in writing. One needs to look no further than comparing someone's handwriting in a letter addressed to someone else with the same individual's handwriting on a shopping list which is intended to be read only by themselves. The former is expected to be more legible than the latter. The sociopragmatic dimension is relevant not only synchronically, but also diachronically, which is evident from examples such as the decrease of pictography, caused by the physiological facilitation of production but ultimately made possible only by the gradual establishment of social conventions in a literate community. It is these conventions that allow the shift from an iconically motivated system to a largely arbitrary system without losses in efficiency (cf. Section 3.3.2.2). The point is made: sociopragmatics must not be overlooked, and its treatment must not be postponed.

The above characterization of how the original subbranches of Naturalness Theory could be reconceptualized for grapholinguistics left out *Natural Orthography*, a third subbranch of Natural Grapholinguistics. Norms were not treated explicitly in the subbranches of original Naturalness Theory. However, the high level of standardization, and with it, the importance of regulations, are specific features of writing. In stark contrast, orthoepy, the standard of the spoken modality of language, is not nearly as elaborated as orthography. What contributes to the high degree of normativity in writing is a number of its prototypical material features: most crucially, its relative permanence in comparison with fleeting speech, and the asynchrony of communication, i.e. the absence of the producer during the addressee's reading process.

The consideration of the level of norms in the present sketch of a Natural Grapholinguistics has consequences for Naturalness Theory by broaching the following questions: How can the naturalness of norms be assessed? In the case of orthography, which is most often an external standardization decided on by certain authorities of linguistic policy, one method of evaluating the naturalness of norms is to analyze the behavior of these authorities in the context of orthography design. What are they basing their decisions on, in what pace are they intervening with the system? The consequences of their 'behavior' reflect themselves most clearly in the product, the orthographic module of a given writing system. Not unlike the semiotic relations between material graphetic units and linguistic units which constitute graphematic units, orthography is constituted by semiotic relations between standardized spellings and the underlying graphematic units inside or sometimes even outside of the graphematic solution space.

An orthographic rule can be considered natural when it codifies as correct a spelling that is part of the graphematic solution space. The *most* natural orthographic rule licenses as correct the possible spelling – if there is more than one – from inside the graphematic solution space that is most natural with respect to the naturalness parameters of the linguistic and processing fits. An unnatural orthographic rule, by comparison, selects a spelling as correct which is not inside the graphematic solution space. The relevant actors responsible for creating an orthography must, on the one hand, stay as true as possible to the graphematic and graphetic modules of a writing system. On the other, their authority grants them the power to mend unnaturalness in these modules. A crucial aspect of a naturalist evaluation of orthography is whether it, just like the graphetic and graphematic modules, is a systematic module. This includes the question of whether orthographic rules are in relation to one another. To recite an example of a situation in which this is not the case, consider character simplification in Chinese. In this series of reforms, the interconnectedness of orthographic rules was neglected, which in turn led to an increase of opacity in the orthography although the actual goal had been to render the writing system easier from a processing point of view. Some of the systematicity of the graphematic module was eliminated when elements which occur throughout the system were not altered in a consistent manner. Although from a physiological and cognitive standpoint, a number of graphemes were made more natural individually, under a global perspective that takes into account the relations between graphemes, a certain degree of unnaturalness was introduced into the system. This unnaturalness, arguably, weighs just as heavy as the benefits the simplification brought about (cf. Handel 2013; Section 3.4).

In line with traditional Naturalness Theory, the aspects of orthography discussed so far are systematic (i.e. linguistic) – does an orthography fit its writing system? – and psycholinguistic – is an orthography easy to process? – which, again, leaves us with sociocultural considerations as a third cornerstone. What has been tacitly implied above is that every writing system has an orthography and that this orthography is artificial. Both of these statements are untrue, which proves crucial for the subbranch of Natural Orthography. In fact, the orthographic module of writing systems is optional, and not every writing system has one. Furthermore, diachronically, not all writing systems that are now equipped with an orthography have always had one. Consider the German writing system: in pre-modern times, various spellings of a word cooccurred even within the works of a single scribe (cf. Elmentaler 2018). German orthography developed gradually and slowly and is not artificial, but rather the result of conventions that the literate community agreed on; it is shaped by an *invisible hand* (cf. Section 1.3.4). At some point, this "naturally grown" orthography was codified, however, which also marked the point at which internal regulations became externalized and externally codified.

By contrast, in writing systems that have not been in use for such a long time, which is most ostentatiously the case for newly created writing systems, there was not enough time for an orthography to develop in a way similar to German orthography. Instead, orthographic decisions are often made early on in the process of literacy development, sometimes even before a writing system is even in use. This, as has been pointed out, can sometimes prove to be *too* early. At this stage, orthographic intervention can harm the goal of bringing literacy to a community. Thus, it can prove a sensible decision to give the community time to use the writing system and to settle the most pressing orthographic questions on its own (cf. Section 3.4). The apparent urge of orthography mediators, most often people from the outside developing literacy for and with an illiterate community, to devise an orthography from the get-go is an apparent side effect of our prescriptive view of writing, our "normative expectation" (Karan 2014: 109). When users of standardized writing systems think of writing, they do not just think of writing, but of *correct* writing. This is because when there exists an orthographic module in a writing system, it is phenomenologically primary to its graphematic module (cf. Schmidt 2018). It is the surface manifestation of a writing system that we – whether as ordinary users or as linguists studying it – are always dealing with first, and only through an analysis can we arrive at the underlying graphematic regularities beneath it. As a symbol of normativity, orthography has lost its function of guiding spelling, and instead strictly regulates and curtails writing (cf.

Maas 2015). This entails social ramifications of its own which can be summarized as a shift to prescriptivism. Variation becomes deviance and deviance becomes erroneous, and errors become socially charged.

These remarks prove that the level of norms should not and cannot be ignored by Naturalness Theory. A detailed investigation raises crucial questions pertaining to the usefulness and naturalness of standardizations in general. Conclusions that can be drawn from the present study include that standardizations should serve users in making a system more efficient in respects in that it might not (yet) be. They should guide, but they should not regulate too strictly. They should regulate where necessary, but hold back in questions where variation is not detrimental to communication, but instead a resource. A reflection of this comes from the conventions of the graphetic module. As described above, the orthographic module regulates mainly the graphematic module, i.e. spellings. It does not explicitly regulate the materiality of writing. However, graphetic norms exist, but they are implicit. In cases in which they are explicit, such as on websites giving advice on how to design a CV or a cover letter (*do not use these fonts, use this font size,* etc.), they are not officially codified like an orthography usually is. When they are 'codified' in the loose sense of 'written down', as in guidelines on how to format a paper for submission to a given scientific journal, for example, the norms' scope is local: different journals have different guidelines, and some might not even have any. For graphetic rules, the consequences of deviations vary: an 'incorrectly' formatted paper might be rejected, an inappropriately designed CV tossed in the trash. In sum, however, due to the lack of a global and officially codified norm pertaining to the graphetic module, there is usually much more material variation in writing than linguistic variation.

The introduction of four fits – systematic, linguistic, processing, and sociocultural – is another modification of Naturalness Theory. It brings order to the existing theory and simultaneously adds new analytical perspectives.

The *systematic fit* was described for scripts, but in theory, it can be used to assess all types of systems. Scripts, when interpreted as divorced from the writing systems they are employed for, are inventories of visual basic shapes. They are no semiotic systems since the units they consist of are not themselves signs. However, within a script, the units stand in complex relations with one another. In this sense, the systematicity of a system, its systematic gaps, etc. can be evaluated descriptively. In theory, this could also be done with phonologies. As established in NP and argued in this thesis, phonology is non-semiotic (cf. Section 1.2.3.2), which means questions such as 'does Thai phonology fit the Thai language?' are, with minor exceptions,[325] not feasible, mostly because a phonology is a constitutive part of a language instead of an optional part like graphematics. However, whether a given phonology is a coherent system in itself *can* be evaluated analogously to the systematic fit which was assessed here for scripts. For example, the lack of a voiced velar plosive phoneme in Dutch phonology is a systematic gap: there is a /b/ opposing /p/, there is a /d/ opposing /t/, but there is no (native) phoneme /g/ opposing /k/. The systematicity of such a gap can manifest itself in the outcome of errors (such as |ᒐ| in Roman script), but it can also be the target of allophony/allography. As systematic gaps, these gaps are still somehow part of the system. Statistically, similarly to |J| among the uppercase basic shapes of Roman script, phonemes can be outliers: /h/, for example, is the only glottal phoneme in German. Generally, assessing the systematic fit of a system is a descriptive endeavor. For phonology, of course, the usefulness of doing this might not be self-evident, and in NP, the focus was on the physiological effort needed for processing phonemes in sequence rather than the phonemes' place in a phonology. However, it must not be neglected that the systematic fit has a bearing on the processing fit, which could be shown for scripts.

[325] A possible question could be whether there are enough phonemes in a language's phoneme inventory and which phoneme combinations are allowed phonotactically. The number of phonemes and, in turn, possible syllables could influence a language's potential to phonologically differentiate between distinct morphemes, which would avoid homophony.

As mentioned, basic shapes are not signs, but as soon as they are used to represent linguistic information, they take part in graphematic relations, i.e. graphemes, which lend themselves to a semiotic analysis that centers on the question of how well signantia fit the signata they are semiotically related with. Since writing systems operate on the basis of underlying languages, the evaluation of these semiotic relations was termed *linguistic fit*. Various facets of the relationship between signans and signatum can be assessed, and the naturalness parameters described in NM serve as a useful starting point. As these parameters were already established in the original theory, their categorical assignment to a so-called linguistic fit adds nothing new to Naturalness Theory. However, the explicit separation between descriptive structure and the effect this structure has on processing represents an innovation. In NM, a central assumption was that an unnatural semiotic structure has is detrimental to how it is cognitively processed. While this, of course, appears to be a highly plausible assumption, it is by no means self-evident. A separation of these two aspects is warranted not only by exceptions in which the two are not congruous but also by the fact that descriptive structural naturalness and processing naturalness are assessed in different ways. Proclaiming pictography as a natural feature, for example, appears reasonable with regard to perception and cognition. However, such a claim is problematic when considering that pictography is ill-suited for the graphematic representation of an entire language since not all elements of a language (including function words, abstract concepts) can be represented pictographically.

An additional advantage of this separation is that it allows the inclusion of parameters that can be evaluated *only* either regarding their linguistic fit or their processing fit: for example, it is not possible to descriptively assess the optimal shape (in the sense of "length" or Kolmogorov complexity, cf. Section 1.5.3) of a linguistic element or structure, for nothing in its descriptive semiotic makeup reveals whether, for example, a one-syllable or two-syllable word is linguistically more natural. In processing, however, such a parameter is of importance, as the question of what shapes of signs are processed more easily than others can be answered on the grounds of external evidence. All in all, a separation of the semiotic linguistic fit and the processing fit is a reasonable modification of the theory.

A criticism of Naturalness Theory that was raised in its comparison with usage-based approaches (cf. Section 1.5.4) is that it does not make entirely explicit the cognitive processes that are affected by certain semiotic structures. The optimal shape of a written word, for example, affects, in a cognitive sense, working memory, and in a physiological sense, visual perception. Alas, this weakness of the theory could not be overcome in the context of this study since there is a fundamental lack of empirical grapholinguistic evidence with respect to many of the naturalness parameters. Without further experimentation and new data, a description of the effects that parameters of the systematic and linguistic fits have on the processing fit, and on which physiological and/or cognitive processes in particular, remains, for the time being, impossible.

3.5.2 Re-evaluation of theoretical grapholinguistics

In his rejection of a 'structural graphemics', Daniels (1991) claimed that writing cannot be treated with the same conceptual tools as language since writing and language differ fundamentally (cf. Section 2.2.2.1). He not only deemed a structuralist analysis of writing futile but also discarded grapholinguistics concepts such as the grapheme, a unit which is emulating (largely) uncontroversial linguistic concepts such as the phoneme or the morpheme. However, no alternative way of comparing diverse writing systems – with the exception of their respective types, i.e. the linguistic units that they represent – is established. Instead, the focus of grapholinguistic research remains on historical reconstruction and individual descriptions of writing systems. Meanwhile, a theory of writing continues to remain a desideratum (cf. Watt 1998). As this study has shown, writing *can* be treated analogously to language. If it could not, a treatment of writing within the framework of Naturalness Theory would have been pointless. In fact, I argue that writing *must* be treated similarly to language to make possible description, comparison, and, most of all, the establishment of a theory of writing that offers explanations of why writing is the way it is and why it has developed this way. Separate historically and philologically oriented descriptions of diverse writing systems are also respectable and necessary enterprises, and in much of the grapholinguistic literature – predominantly its Angloamerican strand –, such descriptions are the cornerstone. In the end, however, minute descriptions, as excellent as they might be, are not automatically of value for a theory of writing if they are not designed in a way that enables an integration into a larger theoretical picture. At this point, not only descriptions but descriptions made in a uniform, comparable way become the basis of a prospective theory of writing. For such a theory to work, a general model of writing systems complete with shared concepts and terminology becomes an absolute necessity.

The reason why writing can be treated like language is simple: writing is based on language, and even more so, it is dependent on language. It is a myth that writing is a system independent of language, or even its own language system (cf. Section 2.1). As a modality of language, writing is a part of language, and as such, it *is* language. The fundamental core of this argument lies in the fact that like language, writing is structurally complex and compositional: units from lower levels are combined to form larger units. Unsurprisingly, it is not coincidental that the units and structures of writing, even though their materiality gives them a certain degree of otherness and uniqueness in comparison with abstract linguistic units and acoustic units of speech, always reflect and represent linguistic structures. If graphic marks do *not* represent language, they are not writing.

What should and could a theory of writing achieve? As already implied, it should provide generalized explanations of how writing systems work, and, importantly, why they function that way. Like all theories, a theory of writing should be based on empirical evidence. This, due to the lack of evidence in some areas, poses a challenge. Evidence serves to draft the first version of a theory of writing. This version of the theory needs to be revised as soon as new relevant empirical evidence is gathered.

The enterprise just sketched failed at the first step outlined above: the lack of a uniform method of describing diverse writing systems makes it impossible to compare research on different writing systems and to correctly interpret, classify, and integrate new empirical evidence. Even within linguistics, there is no consensus on the concepts and terminology of writing. This has tremendous effects on grapholinguistic research carried out in other subjects such as psychology, neuroscience, etc. which also rely on basic linguistic concepts. If not even linguists can agree on how to conceptualize writing, psychologists, neuroscientists, etc. cannot uniformly specify which structures of writing they are investigating in their studies. A shared vocabulary and theoretical framework are crucial.

The modular model of writing systems developed by Neef (2015) is a promising step in the establishment of a descriptive basis for a theory of writing. Although it was not explicitly designed to be a model capable of explaining the structural makeup of all writing systems, it can easily be generalized and modified to serve this purpose (cf. Section 2.2). Its elegant subdivision in modules allows a logical separation of the respective grapholinguistic subbranches of graphetics, graphematics, and orthography. This separation simultaneously reveals the relative imbalance in scientific progress in these areas. When treated in-depth, a description of these modules raises a central question to which there is not one definite and correct answer, but multiple equally acceptable answers (cf. also Haspelmath 2010): how much unity is there in the diversity of writing systems? The inverse question can also be asked: how much diversity is there in the unity of writing systems? The first question better captures what appears to have stalled progress in grapholinguistics: the perception that writing systems exhibit a degree of diversity that renders any attempt to strive for uniform explanations futile. This entails the opinion that any model which is able to account for all these diverse writing systems is too general to be of theoretical value. However, at their core, all writing systems do in fact function equally: they *all* represent language by graphical means. Structurally, too, there must be fundamental similarities: for example, each writing system must have a minimal unit. In the first step, the minimality of such a unit is evaluated graphetically, independently of the linguistic unit that it might represent. Empty spaces offer salient clues for such a segmentation. In the next step, it can be evaluated which linguistic units the smallest graphetic units represent. Logically, there must be a minimal graphematic unit in each system, and this serves as the basis for my assumption of a uniform grapheme definition. The rejection of such a definition comes not only from those who claim there is no grapheme altogether, but, ironically, also from those who aim to define the grapheme in analogy to other linguistic units such as the phoneme or the morpheme. Linguistic diversity, however, does not straightforwardly translate to written diversity. Vast differences in the structure of languages such as German and Chinese, for example, do not necessarily translate to the same type of differences in the structural makeup of their respective writing systems.

The grapheme, as defined in this thesis (cf. Section 2.2.2.1), is a unit of writing that a) differentiates meaning, b) represents a linguistic unit, and c) is minimal. The type of linguistic unit which is represented by the default grapheme in a writing system is the so-called unit of representation. This unit has, quite uncontroversially, always been the basis for writing system typology (cf. Section 2.3.2).

Larger graphematic units are not as universal as the grapheme. While some writing systems have empty spaces which make visible word boundaries, others do not. The graphematic units that were postulated in the description of the German writing system – the graphematic syllable, the graphematic word, and the graphematic sentence – are examples of system-specific (or type-)specific units. The fact that all of them, although defined independently of linguistic units (phonological syllables, morphosyntactic words, and sentences of any kind), correspond to an astonishing degree with exactly these units is further evidence that writing represents language. Deviances – e.g. when a graphematic syllable does not correspond with a phonological syllable – are exceptions. These exceptions show that beyond its function of representing language, writing remains a system of its own. Through its specific features and its development, it exhibits idiosyncratic traits which cannot be explained by its representational function, but whose explanation rather lies within writing itself.

With respect to grapholinguistic diversity, the present study is characterized by a number of weaknesses: although it includes as a crucial type of evidence diachronic evidence of the development of writing systems, it is fundamentally synchronically oriented (cf. Elmentaler 2018 for a criticism of the synchronic nature of grapholinguistics). The writing systems that form the basis of this sketch of Natural Grapholinguistics are modern writing systems which are still in use, and crucially, writing systems that have been in continuous use for a long time. This means they ‘had the chance’ to evolve naturally (cf. Section 1.1.2), which distinguishes them markedly from ancient writing systems which are no longer in use on the one hand and fairly recently invented writing systems which have not been in use for a long time on the other hand. Both of these types of writing systems need to be considered in further developments of Natural Grapholinguistics, as their inclusion could lead to a substantially different outcome or, potentially, a reassurance that the theory outlined here is on the right track. Finally, many writing systems that fall into the same category as the ones which were featured prominently in this study – including German, Chinese, Arabic, Thai, Korean – are not yet studied as well and are thus marked by a lack of available empirical data from the many grapholinguistic subfields. This complicates their inclusion in the theory until more data become available (see below).

A question that has not been explicitly addressed in this discussion yet is why there is even a need for a theory of writing. We have done without one for so long, which makes it appear as if there was indeed no pressing need for it. However, appearances are deceptive: it is not just Watt (1998) who lamented the lack of such a theory, as already outlined in the introduction to this thesis, but also many others. In fact, an abundance of experimental research in psychology, neuroscience, etc. also mentions the challenges that arise due to a lack of theory and the lack of a straightforward methodology of grapholinguistic comparison. These challenges often pertain to model-building, as models are most frequently based on alphabets (and mostly, the English alphabet, cf. Share 2008, 2014). Another aspect that a theory could help elucidate is the investigation of isolated phenomena or features of writing: for example, knowing which parameters underlie the processing of writing systems and how these parameters interact can help inform research on individual parameters such as interword spacing. Top-down knowledge of the larger context of how writing works and how different features contribute simultaneously can help to better understand the functions of its individual components.

3.5.3 Meta-study on the state of grapholinguistic research

As a welcome side effect, this study showcased the breadth of research devoted to phenomena of writing and helped characterize a field that subsumes all of this research: *grapholinguistics* (cf. the introduction to Chapter 2). The variety of research taken into consideration includes the various theoretical and descriptive approaches and traditions that have shaped the field and stem mostly from linguistics or closely related fields as well as the many types of empirical work that have been carried out and that have dealt with questions of writing. One of the challenges of collecting such heterogeneous work that is dedicated to the subject of writing is that for a linguist, it is much easier to evaluate linguistic research on writing than it is to evaluate grapholinguistic research from other fields such as psychology or neuroscience. In their respective treatments of writing, these empirically-driven fields have developed their own terms and theories for the subject, and the amount of psychological work on a multitude of facets of writing alone appears overwhelming. Accordingly, the research that ultimately contributed to the construction of Natural Grapholinguistics was necessarily highly selective. The process of choosing it was deductive and guided by the fragments of the theory already established and the remaining gaps that they highlighted. Naturalness Theory, as an existing and well-developed theory, served as a crucial backdrop and model providing guidance. The two strands of research I want to discuss here are theory and empiricism, as I want to outline the state in which they find themselves in and the work that still has to be done. These two strands largely, but not completely, overlap with linguistics as a theoretical core of grapholinguistics and other participating disciplines – such as psychology, but also sociolinguistics, etc. – as empirical bases of grapholinguistics. This allocation is only rough, however, as linguistics has also offered empirical work and there exist, of course, an abundance of models and theory in empiricist psychology, for example.

Regarding theory and description, modeling writing systems as consisting of four modules is central: the first of these modules is the constitutive language system, all of whose levels (phonology, morphology, etc.) have been the subject of linguistics and are well-described. Since writing is defined as a modality of language, linguistic work represents the basis of every treatment of writing. The other three modules that form the basis of grapholinguistics and constitute their own respective subdisciplines are not as well-studied as language. The first of them, graphetics, is heavily underrepresented in grapholinguistic research (cf. Meletis 2015). On the one hand, this is unsurprising, since, for a long time, linguistics neglected questions concerning materiality, lagging behind disciplines such as psychology which have much earlier started to address questions about the effects of the shape and appearance of writing. It is only in the last few decades and through the contact with neighboring (sub-)disciplines such as media studies and typography that linguistics has opened the doors for questions regarding materiality. On the other hand, the lack of graphetic theory is startling, since the graphetic module is the most consolidated of all the modules and simultaneously the module that lends itself most clearly to a description by means of universal, script-independent categories. Despite the remarkable visual diversity observable in the scripts of the world, the fact that graphetics is concerned solely with materiality rids the module of any links to specific languages. The overwhelming visual variety is thus deceitful, as it conceals the fact that a universal theory of graphetics is much more easily attained than a universal theory of graphematics or orthography. This allows system-independent generalizations, which are the main desideratum of a Natural Graphetics (cf. Section 3.2). All of the naturalness parameters of the graphetic module are universal. This, ironically, makes Natural Graphetics the best-established subbranch of Natural Grapholinguistics from the get-go. While the present study laid a foundation, the description of the graphetic module, specifically with respect to a universal terminology of describing basic shapes in terms of features, is undeniably still in its infancy.

The second genuinely grapholinguistic module of writing systems, graphematics, has been treated mainly within the German grapholinguistic tradition, which results in an overrepresentation of works focusing on German graphematics and an inherent alphabetocentrism in an otherwise invaluable establishment of graphematic concepts and terms. With respect to these concepts and terms, the question of *universality* vs. *diversity* becomes most evident. The comprehensive second chapter of this thesis was not only concerned with critically summarizing previous graphematic work, but also with overcoming the corset of language-specific categories by examining possible universalities of the graphematic module. Interestingly, following Daniels's (1991) rejection of graphematics, graphematic questions proper never really gained currency in the Anglo-American tradition of research on writing. This is also due to another problem, one of terminological, and, more gravely, conceptual underdifferentiation: in English, what should be 'writing system' is often 'orthography'. As argued above, orthography is indeed phenomenologically primary, and in most cases, the data we as scholars of writing are dealing with are orthographic. This, however, does not rid us of the responsibility to acknowledge a conceptual difference between the internal and systematic regularities of the graphematic module and the external, standardized and (in most cases) codified norms of the orthographic module. This serves as the link to the last module of writing systems, orthography, which is also underrepresented in grapholinguistic research, partially also due to the fact that 'orthography' as a term has been appropriated descriptively. Given this situation, questions pertaining to orthography are – if treated at all – relegated to sociolinguistics, especially to the subfield of linguistic policy. Consequently, questions such as how different literate communities deal with written standardization or, from a more structural point of view, which properties of the graphetic and graphematic modules of diverse writing systems lend themselves to orthographic regulation are seldom investigated. Suffice it to say that capitalization or word separation is not as universal an orthographic concern as alphabetocentrism would have us believe.

Let us now turn to the empirical side of the equation. The transfer of the concepts of natural processes and naturalness parameters as well as the consideration of external evidence from Naturalness Theory made available a rough framework that pointed to grapholinguistic research necessary in developing a Natural Grapholinguistics. External evidence must come in the form of studies from a broad variety of grapholinguistic subdisciplines. Many works that help shape the theory stem from psycholinguistics, psychology, and neuroscience, but also historical linguistics and philology, as well as sociolinguistics, just to name a few. While this breadth of research undoubtedly gives the theory its basis as it tackles, using a range of diverse methods, questions of children's literacy acquisition, on-line processing during reading and writing, the historical development of writing systems, literacy development in non-literate communities, and many others, there exist, with respect to evidence that is necessary to build a solid theory, a number of gaps that point to general grapholinguistic desiderata. These can be subsumed under two global desiderata:

— *Research on a greater variety of writing systems*: some writing systems are not well-studied. This includes their description as well as their inclusion in empirical experimentation. In order to include a given writing system in a theory of writing, what is needed is evidence on its historical development, its acquisition by children, as well as its processing both by healthy and impaired adults. The writing systems for which all of these types of evidence are available are overwhelmingly scarce. For many alphabetic writing systems, such evidence is available. However, since it pertains only to one type of writing system, for a universal theory, the abundance of such evidence is not necessarily an advantage. Instead, more evidence for typologically different writing systems is needed.

- *Research on the effect of naturalness parameters on processing*: For some of the naturalness parameters, little or no empirical evidence exists which investigates the effect they have (or do not have) on processing. For example, the effect of endophoric diagrammaticity, i.e. the systematicity of relationships between the units of writing system, has not been empirically studied. While it is an obvious assumption that a diagrammatic writing system – take Korean or Cree – is processed more efficiently than a writing system lacking this diagrammaticity (take, for example, Thai, cf. Section 3.3.1.2), such hypotheses can only be confirmed by evidence. The same goes for some types of indexicality or compositional transparency. Again, in order to be able to separate universal from typological or writing system-specific effects, research on these questions would have to be carried out for a variety of writing systems.

It is not surprising that for a number of naturalness parameters, there exists no empirical evidence as yet, as these parameters were only systematically described for the first time in the context of this study. The theoretical treatment of these parameters and their embedding in an overarching framework of Natural Grapholinguistics now makes visible how they interact and that they are relevant for the description and processing of writing systems. This, ultimately, is one of the achievements of the present study: highlighting gaps in research by attempting to develop a first sketch of a Natural Grapholinguistics. Hope is that researchers from all grapholinguistic subfields will take these gaps as an incentive for further research.

What is an absolute necessity for a Natural Grapholinguistics to work in the long term is the willingness to think outside one's own box. This includes looking for evidence in places one would usually not look for it, and once it is found, actually considering this evidence, cooperating with scholars from vastly different disciplines and, finally, making available one's own findings to a broader audience than just the own community. This is what I have attempted to do, arguably with various degrees of success. The utilization of evidence from all corners of the grapholinguistic sphere raises a number of obvious challenges: in the first step, it is necessary to *find* the evidence. As an example, take the studies of Garrod et al. (2007) and Caldwell & Smith (2012) which propose explanations of why pictography, despite its perceptual benefits, has decreased in writing systems, and how sociocommunicative factors make this decrease possible. These studies had, to my knowledge, not yet been referred to in linguistic works on writing systems. On the one hand, this is due to the fact that they are explanative rather than descriptive, and grapholinguistic focus has always been on description, but also because they are not obviously related to writing systems and a theory of writing. Gaining a better understanding of writing was not the main goal of these studies, but a side effect. What I want to highlight by giving this example is that I am positive there are many more relevant findings out there that I have missed, probably because they were generated in fields that I did not even think of consulting. This, however, could potentially be research that can help flesh out a Natural Grapholinguistics, but it first needs to be found, operationalized, and integrated. This is where I invite researchers from all fields who are interested in writing, i.e. grapholinguists, to cooperate and to make available and promote their work in other fields as well. Interdisciplinary contact is undeniably the lifeblood and driving force of a Natural Grapholinguistics.

3.5.4 A tertium comparationis for the comparison of writing systems

In the preceding sections, several graphetic and graphematic categories were described which, following NM terminology, I referred to as *parameters*. Both in Natural Graphetics and Natural Graphematics, systematic and linguistic parameters, processing parameters, and sociocultural parameters were identified. In this section, I want to discuss how these can inform comparisons of writing systems, what they mean for typology, and how naturalness conflicts and the interaction of the subtheories of naturalness reveal a great deal about the nature of writing.

The discussed parameters can be studied in isolation, but the theoretical framework they are embedded in accounts for the fact that they interact with each other in complex ways. Accordingly, depending on the perspective adopted as well as the epistemological interest, future grapholinguistic research can utilize these parameters in two different ways: (1) in a *holistic approach* to naturalness, the naturalness of individual writing systems can be studied and described. This amounts to in-depth analyses of writing systems which elucidate them from all possible perspectives. It shifts the global question "why is writing the way it is?" to a local level, reformulating it as "why is this particular writing system the way it is?". The results of this endeavor are not traditional descriptions, but explanatory descriptions as they not only list features of writing systems but explain the origin of these features. In a second step, these elaborate individual accounts of writing systems can be compared, which could potentially lead to a high degree of knowledge gain for grapholinguistics. By contrast, in a more (2) *atomistic approach*, parameters can be studied individually. The graphetic parameter of *curvature* or *roundness*, for example, could be studied in a way similar to how *cardinality* (Morin 2018) or *topology* (Changizi et al. 2006) were studied, i.e. not just descriptively, which amounts to qualitative as well as quantitatively statistic analyses of the distribution of this feature in the world's scripts, but also with respect to the effect it has on processing (cf. Section 3.2.2.3). Likewise, the graphematic parameter of *compositional transparency*, for example, could benefit from a greater number of examples and, in fact, more precise examples from a variety of typologically distinct writing systems. In such an atomistic approach, what is gained is a better understanding of individual parameters, which automatically refines the theory and, in turn, the apparatus that is available for the above-mentioned holistic approach.

In both of these approaches, the parameters identified in this study can provide a starting point and a *tertium comparationis*. When two writing systems differ with respect to one parameter, a rough first description of the naturalness configurations on that parameter as developed in this thesis can be used to evaluate which writing system is more natural on said parameter. In this context, Roger's (1995) questions whether some writing systems are 'better' than others can be affirmed, if only at a local level, i.e. a given parameter. At a global level, it appears unfeasible to evaluate whether an entire system is more natural than another system, although it is, of course, a logical possibility that if a system accumulates more naturalness on a greater number of parameters, this, at least quantitatively, gives the impression that the system as a whole is more natural. This, however, raises the question of whether all parameters are equivalent or if, in a conflict between two parameters, the possible outcomes are weighted differently. In other words: is there a ranking of parameters? This is one of the central questions for the future. Another possibility could be, of course, as Fenk-Oczlon & Fenk (1995) argued, that all systems must be, if seen globally, equally natural since they are self-regulating systems and unnaturalness on some of their parameters is automatically compensated for by naturalness on other parameters. In this view, systems only differ with respect to *where*, i.e. on which parameters they exhibit unnaturalness and naturalness.

Grapholinguistic typology is claimed to be still in its infancy (cf. Section 2.3), both with respect to scripts and writing systems. The findings of the present sketch of a Natural Graphetics provide interesting input for a script typology, but they are still inconclusive with respect to a base criterion for a reasonable and useful script typology. One of the possible candidates for such a base criterion that has emerged and does not require sophisticated descriptive work is quantitative visual complexity, a big part of which is so-called *perimetric complexity*. However, the question is whether classifying scripts as complex scripts vs. less complex scripts would result in a useful typology, since the complexity of basic shapes in a script is highly influenced by the size of the script, and the size of the script is in most cases determined by the type of the writing system, i.e. by graphematics. Complex scripts, thus, would turn out to be predominantly scripts used for large syllabaries or scripts that are employed in morphographic writing systems. A different potential parameter to serve as a base criterion is *systematicity*. Systematic scripts could be distinguished from unsystematic scripts. In all honesty, however, it must be contended that a list of parameters for comparison of scripts might suffice and that there is no apparent use for a typology based on a single one of those parameters. Furthermore, as this thesis has shown, the lack of descriptive work in graphetics is still remarkable, especially in the context of the description of basic shapes. There is, as yet, no method for uniformly describing the basic shapes of the world's scripts. It is clear that such a description must proceed visually, and it is obvious that in such a description, *spatiality* is of the utmost relevance, but given the visual variability of the thousands of shapes, it remains doubtable whether a qualitative method of description can be achieved (cf. Section 3.2.1). It might, however, not even be necessary to describe and compare basic shapes holistically, since the individual parameters cover different aspects, such as the types of connections between elementary forms. Scripts can readily be compared with respect to those parameters. In any case, establishing a script typology and using it for further research is a cyclical process: new findings will influence the existing typology and the typology will guide the research.

As for writing system typology, which is much more advanced than a typological classification of scripts, it has been claimed that more fine-grained typological distinctions are necessary as the types of writing systems that have been assumed thus far fail to capture all of the dimensions in which writing systems can differ (cf. Weingarten 2011; Gnanadesikan 2017). This is where the parameters of Natural Graphematics come into play. A promising parameter that has, in the past, been used for minor refinements of phonographic types of writing systems, particularly the alphabetic type, is graphematic *transparency*. On this parameter, what is most interesting is the relation between phonographic and morphographic transparency, as these conflict in languages with complex phonologies. In such cases, one type of transparency must necessarily be dominant, which has led to the assumption of, for example, a "morphophonographic type" in which morphography plays a crucial role (cf. DeFrancis 1989: 71; Hill 1967; cf. Section 2.3.2). Thus, an assessment of the graphematic transparency of different alphabets, but also different abjads or abugidas can lead to a refinement of typological distinctions, and the same can be achieved for non-segmental syllabaries and even morphographic writing systems, as long as phonography also assumes a certain role in them. The same can be done for the other parameters. While I would not propose a wholly new typology of writing systems based on any one of the parameters of graphematic naturalness, they can at least modify the existing typologies which are all based on the parameter of *unit of representation*. Hypothetically, however, the parameters offer not only ways of refining existing typologies but can indeed also serve as base criteria for new typologies which are independent of the phonography-morphography distinction based on the parameter of *unit of representation*. With the help of *figure—ground*, for example, typological distinctions could be made about how writing systems indicate word boundaries, for example, with unspaced writing systems such as Chinese and Thai on the one end of the spectrum and spaced writing systems such as alphabets on the other. Between them, on a continuum, there lie those systems that do not exhibit spaces but are equipped with other features that mark word boundaries, such as script alternation in Japanese. Note that a question that must precede such a typologization based on any of the naturalness parameters is what purpose the resulting typological classification should or could serve. It is only after this question has been answered reasonably that the parameters should be put to use. Then, however, the possibilities are manifold.

One of the central cornerstones of Naturalness Theory is the concept of naturalness conflict. This is true also for the outlined Natural Grapholinguistics. The most central conflict in writing reproduces the struggle that is at the core of all communication: the struggle between sender and receiver, in the case of writing writer and reader. A finding that was foreshadowed by various assessments in the literature is that in writing, perception is primary. The evidence presented in this study supports this. A demonstrative example came from children's difficulties to produce modified links between two graphs in handwriting (cf. Gosse et al. 2018). "Modified" pertains to the fact that when in cursive handwriting, two basic shapes are produced in sequence, effects of coarticulation occur since the graphs that materialize the basic shapes must be connected. In fact, continuity and connectedness of strokes and graphs had been identified as naturalness parameters (and, in a dynamic view, natural processes) of handwritten production. The challenge that modified links, which assure a continuous production process, appear to pose is thus not straightforwardly explainable. Not if perception is disregarded, that is. One possible explanation based on perception is that basic shapes are stored as invariant visual representations, which corresponds with their descriptive definition as abstract visual configurations. If the actual product that is produced differs from the mental representation, this likely requires additional cognitive effort, and the visual invariance that is preferred by perception and cognition is violated. As Watt put it, "the program is merely a servant to the pattern" (cf. Watt 1988: 201), and a deviation from the pattern on the grounds of a modified program might cause the observed problems with modified links. However, that is not the end of the story. Other evidence suggests that the hierarchy between perception and production is not fixed, and that production can also exert a profound effect on perception. This was at least one of the possible explanations for the results of the experiment in which participants had severe problems retrieving the shape |g| from memory, producing it, or even recognizing it amongst a number of ill-formed distractors (cf. Wong et al. 2018). Unlike the alternative basic shape |g| associated with the grapheme <g>, |g| is almost never produced in handwriting. The cognitive representation of the 'pattern', thus, even though it is visually ubiquitous in the graphetic environment, might be deprived of facilitative input from the 'program'.

Another vital finding of this naturalist grapholinguistic sketch is that the different fits themselves are in conflict. As these fits are based on different types of linguistic or extralinguistic foundations, this points to more fundamental antagonisms at the heart of not only writing, but language. Strikingly, the fits appear to strongly correlate with the different sublevels of naturalness. What is natural with respect to the linguistic fit depends mostly on the type of the language that is represented graphematically, so the linguistic fit largely correlates with typological naturalness. This is most obvious in the discussion about a fitting *unit of representation*, and most of the other parameters are heavily influenced by the configuration of that parameter. The systematic fit of scripts is assessed at a universal level: since the description of scripts and the evaluation of their systematicity is independent of language, the descriptive principles and features remain the same regardless of the script in question. The processing fits of both scripts and writing systems, too, are universal, i.e. system-independent in nature, since the physiological and cognitive makeup of humans does not differ with respect to the scripts and writing systems that are used. However, as evidenced by the fact that readers of unspaced writing systems such as Chinese or Thai do not experience problems even though their writing system exhibits unnaturalness with respect to the parameter of *figure—ground*, system-dependent naturalness can be introduced or influenced by system-dependent features of systems, and users can become familiar with these idiosyncrasies up to a point where they become natural. Finally, the sociocultural fits of both scripts and writing systems are, unsurprisingly, most relevant at the system-dependent level. While parameters such as technological availability are universal, their values are system-specific. By contrast, the values of, for example, the processing parameters are more universal. Thus, using leaves as a writing surface for the Burmese writing system might be natural system-dependently since it is influenced by the material that is available. It is socioculturally determined features such as these that can override both the descriptive fits (linguistic and systematic) and the processing fits and decrease naturalness on them. The parameters of the sociocultural fit also lead to a situation in which the questionable claim "every language gets the writing system it deserves" could be rephrased to "every literate community gets the writing system it deserves", a thought that will be revisited in the Conclusion below.

3.5.5 Practical applications

A theory of writing has practical value as well. Some of the applications that I want to discuss were already mentioned by Weingarten (2011: 14) in his suggestion of a *comparative graphematics*. As he observed, findings obtained in comparisons of writing systems are valuable in a number of contexts. Natural Grapholinguistics is inherently comparative but not constrained to the graphematic module as it is concerned with all modules of writing systems.

One possible practical application is type design: the graphetic naturalness parameters of the processing fit can be taken into consideration as design principles in the creation of typefaces for multiple contexts, whether for children's literacy acquisition, dyslexics, or more generally in contexts in which legibility is of utmost importance. In this vein, an interesting question for further research could be how type designers already implement (implicit) knowledge of graphetic naturalness in their design and decision-making processes. A critical re-evaluation of typographic and type design reference works with respect to how they treat the parameters would be valuable in that it could highlight how much of a Natural Grapholinguistics is already 'out there' in practice. In the recent past, an interesting trend in the direction of a 'comparative type design theory' can be evidenced (cf., for example, Wittner, Thoma & Harmann 2019) that suggests type designers also strive for more global knowledge of how type design affects processing.

The development of writing systems is a more global practical application. Here, Natural Grapholinguistics can be useful at multiple levels, starting with the creation of a new script (if that is necessary or desired), covering the makeup of the graphematic module, the question of an orthographic standard and, crucially, relevant sociocultural variables. With the help of the naturalness parameters, a checklist of possible steps for the process of literacy development could be devised. Even though it must be carefully adapted to a given language and a given community, such a checklist could serve as a guide that highlights necessary steps and the aspects that must all be accounted for. I am aware of the fact that the practice of literacy development has a long-standing tradition, and with it, established methods and conventions. There might still be use for the naturalness parameters, which can elaborate on oft-cited works of literacy development such as Smalley (1964) and Cahill & Karan (2008).

Not exactly a practical application, but a theoretical application that can have major repercussions for practical applications such as interventions for dyslexia or rehabilitation for people with acquired impairments of reading and writing is the development of more universal models of reading and writing, which has been a desideratum for some time (cf. Frost 2012; Share 2014). Natural Grapholinguistics can serve as a more global theoretical backdrop for models of reading and writing, as it takes into account a multiplicity of parameters as well as their interaction. Also, the theory accommodates all types of writing systems and can help broaden models that are so far based mainly on alphabets.

Literacy instruction is another possible application of the theory. To some degree, instruction is already informed by knowledge of how children learn to read and write and what factors prove crucial in this process. However, as with models of reading and writing, Natural Grapholinguistics brings a little bit of order to a telling, but partially chaotic picture.

Lastly, to cite Weingarten (2011: 14), understanding diverse writing systems in a larger context can help understand those that have not yet been deciphered. At this point, I do not want to offer any concrete suggestions of how Natural Grapholinguistics might possibly achieve that, but I do hope that the theory will help scholars who are on the verge of cracking an undeciphered system by giving them a more global picture of the general nature of writing which, as long as an undeciphered system truly represents writing (vs. a non-linguistic system), must inevitably also be at its core.

Conclusion and outlook

> I regard a natural graphematics [in the sense of grapholinguistics, D.M.] not only a possible, but a promising way of deepening the description of phenomena of writing and reaching explanations about their development. However, for this purpose, the empirical basis is – in comparison to classical fields of linguistics – still very meager. (Munske 1994: 22, my translation)[326]

It is high time that writing systems are given the elaborate scholarly treatment that they deserve. This study is a critical step in this direction. It is fragmentary, and it probably raises more questions than it can answer, but it is promising. It highlights how a theory initially designed for language can be productively extended and modified to explain the nature of writing, which must be regarded not only as a modality of language, but also as a system of its own complete with its distinct features. The most important achievement of the present enterprise is that it clearly laid out the steps that need to be taken in order to gain a better understanding of the nature of writing.

In the introduction to this thesis, I quoted Watt's (1998: 118) quest for answers to the questions "why each such writing system is the way it is, instead of some other way, and why all such systems have in common what they have in common". These questions, I argued, constitute the very heart of grapholinguistics. While the answer to these questions is multilayered and elaborate, its gist is almost trivially straightforward: human physiology, cognition, and communication have shaped and continue to shape writing. These three cornerstones not only make each writing system what it is but are also responsible for the common core of the world's diverse writing systems. One could argue that the same is true for language in general, including the thousands of languages of the world, and that would indeed be accurate. Accordingly, the "central goal of linguistic theory is to shed light on the core of grammatical principles that is common to all languages", Kager (1999: 1) declares, adding that from a large body of linguistic research "a broad picture emerges of 'unity and variety'". Given its comparative nature, the proposed Natural Grapholinguistics has the potential to reach precisely that goal, and as several findings presented in this study have shown, the common core of written phenomena can be uncovered with a fitting theoretical framework and the necessary evidence. In fact, when compared with the search for universals in language, investigating universals of and in writing proves a much more manageable endeavor.

Firstly, this is due to the fact that writing is a much younger phenomenon than language. While the visual richness of the world's scripts might be off-putting as it gives the impression that writing systems are as diverse as the languages they provide with a written form, this assumption is a fallacy. Behind visual variety lies a central common core and a guiding thread that can be identified: writing systems need to fit their respective languages, but more importantly, they need to fit their users, specifically their (processing) needs and (communicative) wishes. Although different scripts and writing systems have developed in varying directions over time, their core remains the same, as do the key factors in the history of writing. When it comes to the three subcomponents of grapholinguistic naturalness, the linguistic fit of writing systems constitutes a predominantly typological matter, while the processing fits of writing systems and scripts are system-independent as they must cater to physiology and cognition, and the sociocultural fits of writing systems and scripts, not surprisingly, function at the sys-

[326] „[...] daß ich eine natürliche Graphematik nicht nur für möglich, sondern für einen vielversprechenden Weg halte, die Beschreibung von Phänomenen der Schriftlichkeit zu vertiefen und zum Erklären ihrer Entwicklungsprozesse vorzudringen. Allerdings ist hierfür die empirische Grundlage – im Vergleich zu den klassischen Bereichen der Systemlinguistik – noch sehr schmal."

tem-specific level. In all of these respects, writing echoes language. This is expected since writing, as a semiotic system based on language, is inseparably tied to language. Thus, it is obvious that many of the same steps that are necessary in the establishment of theories of language need to be taken in order to carve out a theory of writing. One might say the study of writing is like the study of language, only in a microcosm. Accordingly, given these parallels between language and writing, one does not need to start from scratch in the establishment of a theoretical framework for writing. Naturalness Theory appears to be a suitable match for discovering explanations for the nature of writing. However, I want to repeat that the specific linguistic theory used as a starting point for a theory of writing is not fixed, and other approaches – such as usage-based linguistics – might provide equally intriguing bases for a treatment of writing. A combination or comparison of the suitability of these approaches for the subject of writing might be a fruitful endeavor for the future. In any case, and this is a fact, writing must be treated theoretically and grapholinguistics must strive for explanation. If that is done and the pieces of the puzzle are put together, the result can be a very sound, almost trivial picture.

What follows is a fictional scenario that illustrates how Natural Grapholinguistics can provide explanations. Imagine a person (as a placeholder for a community) who wishes to invent a writing system for his language that allows written communication between the members of his community. The first question he is confronted with is whether he uses an existing script or whether he invents a new script instead. This decision is influenced by a number of factors: does the person know what writing is, and that it already exists elsewhere, for other languages? Is the person already literate in a different writing system? Is someone literate from outside helping him create the writing system? Additional factors pertain to resources: is technology (interpreted very broadly) available in the person's region? Are there computers, smartphones, is there a connection to the internet? If existing scripts are familiar and represent possible choices, but are associated with different cultures that are, for some reason, negatively connoted, this might prove to be a knock-out criterion. Finally, the person decides to invent a new script. First, however, in this special scenario of a custom-tailored script for the language this person wants to write down, a decision has to be made on a unit of representation. This requires sophisticated metalinguistic work which the person might perform consciously or unconsciously: what is the language's structure? What level of representation is most feasible? In the case of an analytic morphosyllabic language, the person might decide on a morphographic system, also since he, if not yet literate in any language, probably exhibits no phoneme awareness, which makes phonological segments inaccessible for him. The drawbacks of large inventories of basic shapes and graphemes that are caused by morphography are outweighed by the possibility of pictography, the script creator realizes, which will allow his fellow community members to learn and memorize the units of the system quickly. The shapes he creates are pictographic, at least for words and morphemes representing concrete objects. For abstract concepts, he comes up with arbitrary shapes. Producing pictographic basic shapes is cumbersome, since it in some respects resembles drawing, and the writing process is not yet efficient and quick. Because it poses a challenge to come up with as many shapes as are needed for the morphemes in the language, the script inventor reuses some of the already invented ones by inverting them horizontally. This will help him remember how they are produced, and he effectively needs to memorize fewer shapes. The shapes themselves are rather curved in nature, since what is available as material is palm leaves and spiky stems from other plants to carve on the leaves. When he unveils the writing system to his community, the other members start using it. They make mistakes on the extrinsically symmetrical shapes with different values, reversing them so that they are oriented in the direction in which most other shapes in the script are oriented, which is also the direction of writing and reading. When later, paper and pens become available as writing materials, the production process becomes quicker, and shapes become connected and more cursive. They lose their pictographic character, which is not a problem for communication, however, since the complex communicative interaction between the now literate members of the community leads to an establishment of conventions. When the language in question comes into contact with a different language and words of this foreign language need to be written, the morphographic graphemes start to be used only for their phonological value. At one point, the script might be encoded in Unicode. Keyboards and other technology become available, and basic shapes are cemented in their appearance and become stable. The mixing of morphography and phonography introduces a large degree of variation, i.e. possibilities of spelling given utterances. A committee is formed to decide on a standard, an orthography. The spoken language develops more quickly than the written, and the orthography needs to be reformed. This story, of course, continues.

All of the developments in this scenario can be explained by Natural Grapholinguistics. The theory accounts for the development and the predictable parts of the change of scripts and writing systems, for the frequency of phenomena, errors that are made, factors that influence sociocultural preferences, etc. It is not perfect, and in many cases, it will run into problems and lack explanations for certain phenomena, and this is precisely where grapholinguistic theorizing needs to continue.

Note that what the scenario above represents is, synchronically, the most marginal case. Nowadays, unsophisticated grammatogenies are rare, i.e. creations of writing systems by people who do not know that writing already exists and/or are not literate in an existing system. Scripts are extremely seldom invented and are nowadays commonly not written on leaves. The more pressing, but equally explainable scenarios for a naturalist treatment of writing are those in which scripts and graphematic principles and regularities are adopted and adapted, leading to complex interactions between donor systems and target systems, which also makes it imperative to consider the traces that the donor system leaves in the target system. The distinction between systems invented from scratch and systems that were heavily influenced or shaped by existing systems is central and leads to crucial differences in how naturalness is reflected in a writing system. This observation is paramount going forward with a Natural Grapholinguistics.

In the course of this study, two provocative and persistent questions regarding writing were posed. The first one was whether some writing systems are better than others (cf. Rogers 1995: 31). A very simplistic answer to this would be *yes*, some systems appear to be indeed better than others. However, the answer is not absolute in any case, as investigating this question in an absolute manner is not feasible. This means that it is not entire systems that can be reasonably compared, but the question of how these systems cope with various problems, including how they represent their respective language (*linguistic fit*), how they are visually and graphematically suited for our human capacities (*processing fits*) and how they index and represent socially, culturally, ideologically (and politically, religiously, etc.) what the community wants them to reflect and convey (*sociocultural fits*). An isolated claim such as "morphographic systems are inferior to phonographic ones" (Jones & Mooney 2017: 13) is, simply put, false. Instead, this question must be posed with a complex network of factors in mind and can only be asked in relation to a specific situation or scenario. In case x, morphography might be less suited, but in case y, it might be more natural that phonography. No entire system is better than another system in every regard. In fact, due to naturalness conflicts, a completely natural writing system cannot exist, and these conflicts are dealt with in various ways across different systems. The second question posed in this thesis is intricately related to the linguistic fit, but, as was shown, this automatically connects it to the other fits as well: *does every language get the writing system it deserves* (cf. Frost 2012: 266)? In short: no. If the underlying language were the most crucial and not just one of a number of conflicting variables, a writing system with the most natural linguistic fit (again, only on a number of parameters, never all of them, which is impossible) would be imaginable. However, what is most natural linguistically is not necessarily most natural for processing, and, which is the crucial point in the answer to this question, not necessarily most natural for the sociocultural environment and needs of a community. It is the communicative factor and the embedding of writing in larger, not only linguistic but social contexts that commonly hinder languages from getting precisely the writing system they would linguistically 'deserve'. If the three fits align, however, and sociocultural factors only reinforce what is linguistically natural, as, arguably, is the case for the Korean writing system, for example, the impression can arise that a language indeed got what it deserved. But, more importantly, so did the literate community. Since sociocultural factors, to which orthographic regulation and standardization must be counted, so often have the last say, the initial question should be reformulated accordingly: *Does every literate community get the writing system it deserves?* In this case, the answer is more likely to be affirmative, since the wishes of the community (or political authority, etc.) are shaping the system to begin with.

In the discussion of this study's results, I mentioned some of the points that need to be elaborated further in the context of future research. Most importantly, although many writing systems have already been treated descriptively, they should be 're-described' within a uniform theoretical framework or at least integrated into such a framework with shared concepts and terminology. This is the only way that comparability can be assured. Indeed, and this bears repeating, comparison is most crucial going forward. This extends also to ancient writing systems which are no longer in use as well as modern writing systems that have been created fairly recently, both of which were underrepresented in the present study. Consequently, with the gradual increase of the body of descriptive grapholinguistic work, including also writing systems that have altogether not been described, not only Natural Grapholinguistics must be refined, but also its descriptive foundation. Concepts such as *basic shape* or *grapheme*, as sound as their definition might appear at this point, are not set in stone, and if writing systems are encountered that cannot be accommodated by them, they require modification.

There are a number of tasks that need to be undertaken in the near future. First, the research that is out there, scattered across disciplines and academic cultures around the world and presented in different languages, must be located and integrated into the theory. As this study has illustrated, much of the existing research was implicitly naturalist in its methodology and assumptions, and most importantly, its striving for explanations. As an extensive treatment of the entire phenomenon of writing systems within the scope of a PhD expectedly resulted in a fragmentary picture, much more work needs to be done to find existing evidence from the heterogeneous fields that are subsumed by the interdisciplinary grapholinguistics. Some types of evidence such as evidence from disturbances of reading and writing must be consulted more intensively, and some fields such as literacy instruction must be included to begin with, to name only two examples of what must be done. However, a first outline of the global picture of why writing is the way it is was needed for a start, and going forward, it proves useful in distinguishing the research that is relevant for a theory from the research that is not. Aside from existing research and evidence, more empirical evidence is required for most scripts and writing systems with respect to their systematic, linguistic, processing, and sociocultural fits. It is astonishing that there does not appear to exist – at least not in English – any research on the processing of the Cree writing system, or also the Georgian writing system, which could provide evidence for parameters such as *distinctiveness* (or lacking distinctiveness via *extrinsic symmetry*) and, in the case of Georgian, *curvature*, since the basic shapes of Georgian script consist mainly of curves. In addition to more research, intensified contact is necessary between different fields, and findings must be made available in a global framework. For a theory of writing to advance, everyone interested in written phenomena must be able to become involved, and this necessitates a common ground on which findings on writing are presented in ways that make them more accessible to all interested and invested scholars of all grapholinguistic subfields. Finally, naturalist case studies of writing systems are necessary. In the present context, examples for parameters were given from a multitude of systems, but no single system was evaluated with respect to all parameters. Such a comprehensive evaluation, however, would be an important test for the theory as it likely highlights where the theory is still lacking or requires revision. Such case studies of the naturalness of different scripts and/or writing systems could, in a further step, be straightforwardly compared, which would also allow deepening an understanding of universal, typological, and system-specific aspects of writing.

This outline of a Natural Grapholinguistics is a status report, a collection of desiderata, and a new perspective. It is a start, but most importantly, it is an invitation.

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