Reintroducing *graphetics*: the study of the materiality of writing*

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Graphetics is a subdiscipline of grapholinguistics dealing with all questions concerning material aspects of writing. To date, it has been predominantly excluded from linguistic theorizing because of the implicit general agreement among linguists that the specific shape and look of writing—with its varying features, e.g. typeface, type size, color, features of the writing surface, etc.—do not contribute to the (denotative) meaning or generally, the linguistic structure of written utterances. By contrast, the present contribution attempts to show that the functions of the materiality of writing are manifold—and linguistically relevant.

In the first part of this paper, a definition of graphetics is given and the apparent terminological and conceptual analogy to phonetics is discussed. In the second part, the subbranches of *productional graphetics* (studying writing processes), *descriptive graphetics* (studying the written product), and *perceptual graphetics* (studying recognition, reading, etc.) are characterized. In the third and key part, a spatial model is presented which can potentially serve as the basis of descriptive graphetics. Determined by visual properties—especially empty, i.e. blank spaces at different levels, e.g. word spaces, line breaks etc.—which are inherent across diverse types of writing systems, a number of descriptive graphetic levels and units is postulated and discussed. Finally, the conclusion addresses a range of unresolved issues and desiderata that ultimately serve as a means of incentive and orientation for future grapholinguistic research.

Keywords: graphetics, grapholinguistics, description of writing systems, materiality of writing, basic shape, graph

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1. Introduction

Writing is always a materialization of language. As such, it needs to be visible or—in the case of braille—tangible in order to be seen or felt. Writing must be materialized in order to *exist* and bring structures of language into existence. The interdisciplinary study of writing—increasingly referred to as *grapholinguistics*—is a slowly but steadily growing field. Writing is defined as the visual representation of language. However, given that the specific visual form of a given product of writing most often fails to influence how language is represented by it, the materiality of writing is frequently relegated to the background. While it is central to largely practical fields such as typography but also disciplines like art history which integrate visual and material aspects into their analyses, fields studying language-related questions such as linguistics and psychology often quickly abstract away from the actual appearance of writing which is claimed to not or only minimally affect linguistic meaning or the processing of writing.

Grapholinguistics, however, is devoted to studying all aspects of writing and cannot shy away from also treating its materiality. In this context, a model of the general structure and functioning of writing systems becomes an absolute necessity. 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 that constitute writing systems. A modified version of it is illustrated in Figure 1: a writing system is based on (I) a given *language system* and features (II) *graphetics* and (III) *graphematics* as obligatory modules, and (IV) *orthography* as an optional module of writing. In brief, graphetics provides the visual material used in a writing system, while graphematics links this visual material with the linguistic units it is supposed to visualize. Roughly speaking, thus, the *grapheme* is conceptualized as a dyadic sign with a visual unit as its signifier and a linguistic unit as its signified (cf. Meletis 2019). Some, but not all writing systems additionally exhibit orthographies as normative and externally codified standardizations.[1] Accordingly, the optional orthographic module restricts the possible

[1] Examples of writing systems in use that do without an orthographic standard are the systems in use for writing the varieties of Swiss German. Also, when new writing systems are devised for hitherto unwritten languages, at a first stage, there is often no explicit regulation, i.e. no orthography (cf. Karan 2014).

spellings located in the so-called *graphematic solution space* (cf. Neef 2015): graphematically, the variants *<rite>, *<wright>, *<ryte> or even *<write> are all licensed to represent the phonological string [raɪt], but if what is meant is the semantic opposite of <false>, the *orthographically correct* spelling is <right> (cf. Neef 2015: 716). The modules of graphetics, graphematics, and orthography are each studied by separate eponymous subbranches of grapholinguistics. There exists a considerable amount of research in graphematics and orthography, graphetics is sorely underrepresented. There do exist a number of significant but little-received contributions to graphetics (cf. the overview in Meletis 2015: 20–43), but they are scattered and fragmentary and amount to no coherent account. This paper attempts to provide a basis for such an account by offering a systematic characterization of graphetics along with a basic framework and the most central categories. In other words, while graphetics has existed for some time, it has done so only in the margins of linguistics. This paper aims to reintroduce it to a broader audience and to move it closer to the center.

As elaborated, 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 or exclusively to linguistics but rather to a number of other neighboring disciplines such as

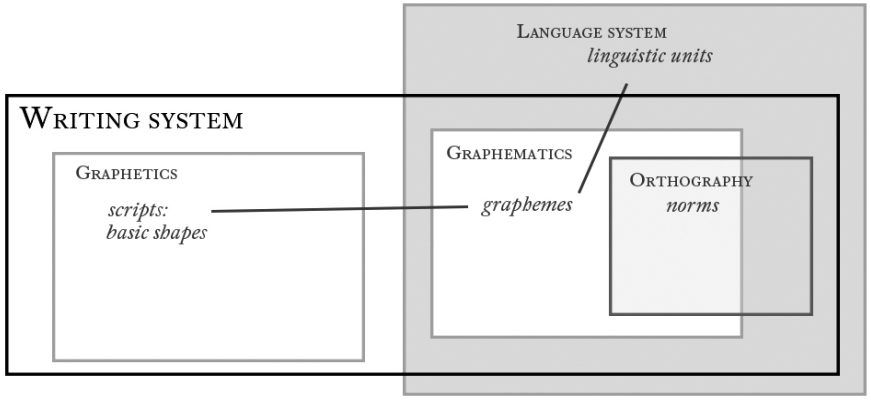

Figure 1. Modular model of writing systems, from Meletis (2018: 61)

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. Unsurprisingly, the research that has treated graphetic questions is scattered across different disciplines, and, deleteriously for the development of graphetics, there is a lack of reception beyond disciplinary boundaries (cf. Spitzmüller 2016: 103). So far, most grapholinguistic works that have addressed graphetic questions have focused on *typography*, which can be regarded as 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 (cf. Rezec 2009: 8). By contrast, I argue that the graphetic module of writing systems is just as relevant as the graphematic and orthographic modules. In the end, one cannot write or read if there is no visual (and/or tactile) material substance. Ignoring this fact would do the study of writing injustice. A number of recent studies prove that an investigation of the interplay between the graphetic and the graphematic modules is a promising endeavor as they identify striking correlations between graphetic form and graphematic function (cf. Primus 2004, Bredel 2008, Fuhrhop *et al.* 2011). In any case, a deeper understanding of the structure of scripts and other visual resources employed in writing systems can, even if it is not located within the immediate core of linguistics, only enrich grapholinguistic research.

Section 2 of this paper offers a definition and characterization of graphetics and critically addresses its seeming parallels with phonetics. Section 3 will then outline the three subdisciplines of graphetics, namely *productional*, *descriptive*, and *perceptual* graphetics. The heart of this paper is Section 4, in which the spatiality of writing proves constitutive for the graphetic module. Here, the levels of *micro-*, *meso-*, *macro-*, and *paragraphetics* will be introduced along with the graphetic phenomena that they incorporate. Section 5 concludes the paper and gives an outlook on the work that is still necessary to advance the field of graphetics and, generally, our understanding of the nature of writing.

Two limitations must be addressed in advance. Firstly, this presentation of the field of graphetics will be preliminary as it is impossible to take into account all of the world's scripts in one study. Secondly, this paper is inevitably shaped by my background. I am a generalist asking broad theoretical questions and aiming for a bigger picture rather than a

specialist in any given writing system. Although in theory construction, we need to be aware and critically reflect on biases, my own research might still implicitly be Euro- or even Germanocentric, which might appear even more so given that most of the existing literature on graphetics that is mentioned in this paper originates in the German-language grapholinguistic community (and, unsurprisingly, focuses on German). It is central to be aware of these restrictions. Definitive theoretical proposals in the study of a highly complex and variable phenomenon such as writing cannot reasonably be made by a single person from a single field. Where one's expertise ends, other scholars—experts on specific writing systems, scholars from other fields such as psychology, the cognitive sciences, history, etc.—must step in to clarify or fill in the blanks, highlighting the necessity of interdisciplinarity in grapholinguistics.

2. A definition of *graphetics*

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 use methods that are in the periphery of what is considered linguistic, with some arguing that they are in fact *not* linguistic.[2] Thus, similarly to a distinction made in phonetics (cf. Ladefoged 1997, Laver 2017), one could hypothetically differentiate a *linguistic graphetics* from a broader *general graphetics*. This is a question I will leave open for future discussion. Furthermore, it is paramount to note that graphetics is certainly not *only* an auxiliary discipline to graphematics, which it also has in common with phonetics

[2] An example is the perception of different typefaces. Not only can the physiological aspect of the perception of different typefaces be compared to answer questions such as *Which typeface is more legible?*, but due to the often connotative nature of typefaces (or handwriting), the emotional response to them can also be studied. Take the study by Velasco *et al.* (2015), who instructed participants to match round or angular typefaces with taste words and found that round typefaces are associated with attributes such as "sweet" while angular typefaces are associated with "bitter," "salty," and "sour." The authors hypothesize that this could be caused by the fact that round typefaces are easier to process. Their study is undeniably graphetic, but it is debatable to which degree it is linguistic.

which also does not serve merely as 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 (completely) without phonetics, why should we do graphematics without graphetics? Without graphetics, writing would be invisible or intangible—it simply would not exist.[3] There is some truth to what linguists or semioticians who disregard graphetics claim, probably most famously Ferdinand de Saussure (1916: 143): Often, for the meaning of an utterance, it does not matter *how* writing appears, as "an A is an A is an A" (Stöckl 2004: 5f., my translation; cf. also Assmann 1988: 144) no matter what typeface is used or how an individual's handwriting looks exactly (but cf. for the connotative relevance of its appearance below). However, no one can deny that it is imperative that it *looks* at all, i.e. 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.

Even though some parallels exist, the analogy phonetics/graphetics also leads to a number of misconceptions. One of them is that graphetics studies materiality in a solely formal manner and is not concerned with functions (cf. Spitzmüller's discussion and criticism of a structuralist two-world ontology, cf. Spitzmüller 2013: 124, Krämer 2001: 95–105). This characterization falls short: graphetics *is* also interested in functions, but specifically in the functions of the written substance itself (and the practices involved in their production and perception) rather than the functions

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

of the linguistic information visualized by that substance. In the analysis of a product of writing, for example, graphetics does not concern itself with denotative meaning,[4] but with the connotations that are evoked by visual features such as color, typeface, type size, highlighting such as bold print, italics, etc., and with the question whether an additional[5] 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 2, typefaces in Roman script are made to resemble Devanagari, Chinese, and Arabic, and this is achieved solely by the respective type design. The words themselves could be written in a prototypical typeface of Roman script, of course, but in that case, the specific cultural meaning evoked by the culturally specific type design would be lost. This cultural meaning is a fundamentally graphetic matter.

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-

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[4] 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 (see below for definitions)? 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. For example, that in writing systems using Roman script (take German and English as examples), the visually similar but still distinct |g| and |g| belong to the same grapheme cannot be decided on visual grounds (at least not solely), which is more obvious for the visually dissimilar shapes |σ| and |ς| which are allographs of the grapheme <σ/ς> in the writing system of Greek (see below).

[5] The treatment of these functions as *additional* functions and an *additional* layer of meaning—i.e. connotative meaning—is criticized by Ludwig (2007), as he argues that this classification as 'surplus,' as something secondary to linguistic denotative meaning hinders a systematic distinction between linguistic functions and visual (or, more generally, material) functions that are performed by written utterances or their production and perception. However, *graphetics* as it is proposed here has as its central aim also the systematic investigation of the functions of visual materiality independent of linguistic functions.

Figure 2. Pseudoscripts

explanatory, and graphetics is necessarily trans-individual, as it does not primarily study the writing of individuals, but of, for example, entire literate communities. However, the 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 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.).[6] According to Ehlich, the term *graphology*, with its suffix *-logy* as found in designations of other scientific disciplines and linguistic subbranches, which also 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 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. This lack of systematicity in phonetics is what makes the analogous term *graphetics* unsuitable for writing, Ehlich (2001: 65, emphasis in original) argues:

[6] 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).

> 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 dimension of primary relevance for speech, and thus, phonetics, is *time*, while for writing and graphetics, it is (primarily)[7] *space* (cf. Dürscheid 2016: 32f.). The terminological analogy between the two terms, thus, works at a very abstract level, implying only that what is studied by both disciplines is the etic level, i.e. materiality, which does not, however, preclude that this level has an internal systematic structure.

Since it disregards the linguistic level, Ehlich's proposed transindividual graphology would still not supplant but rather be a complementary field to *graphematics* as defined above, i.e. 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. The inner systematics of the graphetic module will be the subject of this paper's remainder.

3. Subbranches of graphetics

By analogy with the subdivision of phonetics, three graphetic subdisciplines are assumed (cf. Fuhrhop & Peters 2013: 182–183). They are deducted logically from a simplified model of communication, starting with

[7] Note that from the dynamic perspective of production (and perception, for that matter), time does play a role also for writing, as writing and reading processes are of course bound to time. However, from the perspective of the product, i.e. the written text, time is not relevant. It is, by contrast, relevant for the product(s) of speech, i.e. spoken utterances.

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 graphs in handwriting?[8] 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 (and perceptual) graphetic research is the study of *character amnesia* in Chinese and Japanese (cf. Xu 2015), a situation in which users of these systems forget how to produce in handwriting specific morphographic graphemes that they could formerly write. Interestingly, in many cases, these users are still able to read these graphemes,[9] underlining that reading and writing processes are to some degree independent of one another.[10] 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 typeface or a specific form of highlighting (**bold** instead of *italics* or underlining, etc.). Choices at all levels of writing, including the material, are—to some degree—"acts of identity" (cf. Hatcher 2008), whether they are conscious or unconscious. This means that these choices

[8] 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 graphonomics and graphetics.

[9] An anonymous reviewer notes that "it is generally true for all writing systems that reading proficiency surpasses writing proficiency," which might be accurate but is not what I intend to convey here: in Chinese, the discrepancy between reading and writing can become striking, and crucially, it is the loss of writing proficiency which had already been acquired that characterizes the phenomenon of *character amnesia*.

[10] 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 *et al.* 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 remain unaffected.

refer indexically and sociosemiotically to the producer and facets of his or her (self-constructed) identity. Following questions are relevant in this context: What was the writer's intention in designing a text in a specific way, and was it motivated socioculturally—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 at another level, the material.

The second subbranch of graphetics is likely the most 'traditionally' linguistic 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 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 *calonh* 'round script' (cf. Coulmas 1996: 55, Watkins 2009: 170, cf. Figure 3), is so visually curved in nature because it was traditionally written on palm leaves. These leaves' fibers are linear, which is why the production of 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

မြန်မာအက္ခရာ သည် ဗြာဟ္မီအုပ်စုတွင် ပါဝင်ပြီး မြန်မာဘာသာ၊ မွန်ဘာသာ၊ ရှမ်းဘာသာ၊ စကောနှင့် ပွဲကရင်ဘာသာများ ရေးသားရာတွင် အသုံးပြုသည်။ မူလပထမ ရှေးမြန်မာ အက္ခရာသည် ထောင့်ချွန်းနှင့် လေးထောင့် အက္ခရာတို့သာ ဖြစ်ကြသည်။ သရေခေတ္တရာ ပြည်နှင့် ရွှေဘိုနယ် ဟန်လင်းကြီးမြို့များ ကောင်းစားစဉ် အခါကာလတို့က ရေးသားသုံးစွဲ ကြသော အက္ခရာတို့မှာ ထောင့်ချွန်းပုံ အက္ခရာမျိုးများ ဖြစ်ကြ၍ ပုဂံခေတ်မှ အင်းဝခေတ် အထိတွင် ရေးသားကြသော အက္ခရာများမှာမူကား လေးထောင့်ပုံသဏ္ဌာန်များသာ ဖြစ်ကြ လေသည်။ ကုန်းဘောင်ဆက်သို့ ရောက်ရှိမှသာလျှင် အက္ခရာဝိုင်းဝန်းလာလေသည်။ အမရ

Figure 3. Extract from the Burmese Wikipedia page covering the Burmese writing system

that are presented in the next section in the cartography of the writing surface are based on a description of the spatial arrangement of writing and are, thus, themselves a product of a script-graphetic analysis.

The third and final subbranch, arguably the most prominent of the three, is *perceptual graphetics* (cf. Meletis 2015: Chapter 4). Similar to productional graphetics, it is not predominantly a linguistic subfield, but rather one that is enriched by research from psychology, the cognitive sciences, neurobiology, and other fields. It is concerned mainly with the processes of perception, recognition and—at the highest level—reading.[11] How is a basic shape or a word that is itself made up of a sequence of basic shapes recognized? At a higher—but not necessarily conscious—level, sociolinguistic questions can be asked, symmetrical to the questions studied by productional graphetics: Which emotions are evoked in the perception of different typefaces? Which 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 is the passionate discourse about the dislike for the typeface Comic Sans, especially in the realm of the internet (cf. Meletis 2020a). This is largely a sociolinguistic issue, but since it has at its core the materiality of writing, it is also a graphetic matter.

As evident from the questions asked by these graphetic subbranches, there exist, similar to the situation in phonetics, two methodological strands or perspectives which Günther (1990) calls *symbol graphetics* and *signal graphetics* (cf. also Bredel 2008: 24). Symbol graphetics describes and attempts to categorize the graphetic resources of the world's writing systems and often calls on extra-graphetic, i.e. graphematic information in order to assemble graphetic categories (such as *basic shapes*, see below) and discover universals or universal tendencies (cf. for example the studies by Changizi & Shimojo 2005 on the number and complexity of elementary forms in the basic shapes of the world's scripts or Morin 2018 on the predominant cardinality of these elementary forms). As such, symbol graphetics bundles

[11] 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, aspects which are often ignored.

questions coming from disciplines such as linguistics, cultural studies, philosophy, history, etc. The sociolinguistic questions listed above are examples of questions studied by symbol graphetics. By contrast, signal graphetics employs experimental methods borrowed from the sciences: the materiality of writing is studied divorced from the linguistic structures it is associated with, and what is of concern is optical stimuli and motor and perceptual processes involved in processing them, and these are addressed using a range of methods, including eye movement studies, imaging technology, and graphonomics (cf. Footnote 8). Accordingly, signal graphetics bundles graphetic questions coming from psychology, physics, medicine, IT, etc. The psycholinguistic questions raised above, thus, are largely of signal graphetic nature.

4. Cartography of the surface: Graphetic levels and units

The levels and units that will be presented in the following sections are constituted visually by "spaces of nothing" between them: I call these spaces *empty spaces*. Graphetic units are to some degree universal, but they differ across writing systems based on where empty spaces are located. The fact that graphetic (and, in turn, a number of graphematic) units are constituted by empty spaces is at the core of the *empty space criterion*. It is fundamentally based on the gestalt theoretical principle of *figure—ground* which establishes "syntagmatic contrasts between a more important foreground or figure and a less important background" (Dressler & Kilani-Schoch 2016: 365), with written units being figures and empty spaces being their grounds. A crucial theoretical question is whether in some cases, graphetic units are only secondarily graphetic, when empty spaces are determined by linguistic units. However, the inverse could also be true, i.e. graphetic units possibly 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 form merely makes *visible* an already existing informational structure or whether it itself *creates* its own informational structures."[12]

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

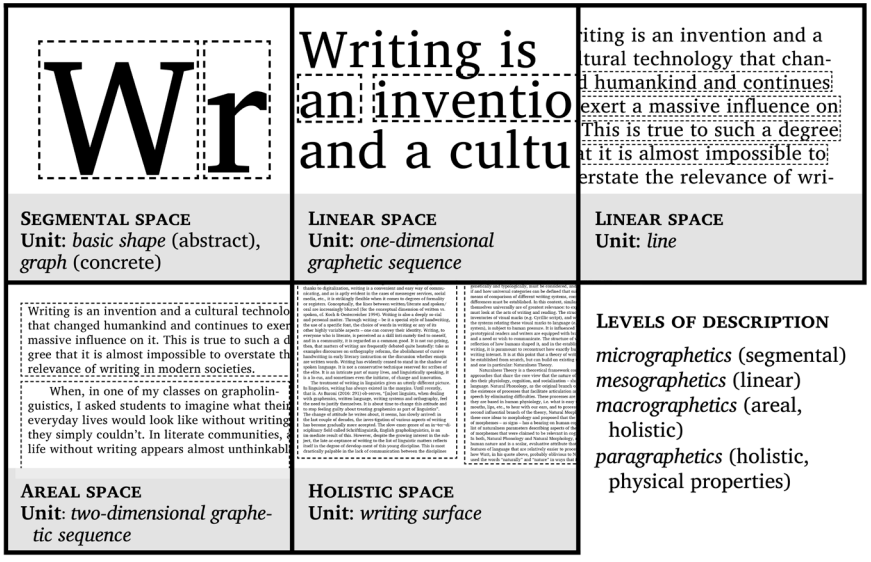

Figure 4. Cartography of the writing surface: empty spaces and the graphetic levels and units they constitute, adapted from Meletis (2015: 116)

The smallest empty space in the graphetic modules of most writing systems is the empty space between basic shapes (see below for a definition), as evidenced by Roman script—provided it is materialized in a typeface with spaces or spaced handwriting and not in cursive handwriting or a decorative typeface in which graphs are connected. In Arabic, by contrast, there is no empty space between most of the segmental basic shapes, as they are connected to each other, even in print. As illustrated in Figure 4, 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*.[13] Following Reißig (2015), I term the practice of

[13] These terms are adaptations of Stöckl's (2004) typographic terminology (micro-, meso-, macro-, and paratypography). By substituting 'typography' with 'graphetics' (cf. Meletis 2015: 119), the terms are broadened, which reflects that typography is 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, these typefaces are still digital and/or printed).

spatially dividing the 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*,[14] originally formulated in phonology, 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.

4.1. 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*. 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). Of course, at the graphematic level, a single basic shape that occupies a segmental space can be in a graphematic relation with a phonological syllable, as in the syllabaries of the Japanese writing system: here, segmental graphetic and, in turn, segmental graphematic units stand for polysegmental phonological units, e.g. the segmental <ぬ> which graphematically represents the mora /nu/. However, in the graphetic module, these graphematic relations are not of concern. 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),[15] while the most

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Both of these fields—typo- as well as chirography—are subfields of graphetics.

[14] The original formulation of the hypothesis 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).

[15] 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,

salient acoustic unit is arguably non-segmental.

Basic shapes, the smallest *units*, are commonly complex, as they are made up[16] of several segments. In German-language grapholinguistics, these segments are sometimes referred to as *elementary forms* (*Elementarformen*, cf. Berkemeier 1997: 242, Butt & Eisenberg 1990: 36, Meletis 2015: 65f.). These elementary forms have been the matter of controversial debate, as some grapholinguists rather opt to treat basic shapes holistically and not to break them down into smaller parts, claiming that a segmentation is not of value, at least not for graphematics (cf. Neef 2005, Rezec 2009: 81, Wehde 2000: 74, Brekle 1994: 171). However, other researchers have, in different contexts, used various methods to attempt a dissection of basic shapes into smaller elementary forms. Such efforts have come from psycholinguistics, the cognitive sciences, semiotics, didactics, and, notably, linguistics (cf. an overview in Meletis 2015: 50–79). The elementary forms that are consistently assumed across different 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.[17] However, the story is more sophisticated than that: for example, Primus, Fuhrhop, and other linguists have suggested that there are some inner systematics to lowercase Roman basic shapes as well as basic shapes from the Tifinagh and 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

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sequences of graphs are often written in a continuous flow, lacking segmentation. Crucially, 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 in the first place.

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

[17] An anonymous reviewer notes that it is "heavily alphabetocentric" to assume that lines, curves, and dots are the elementary forms that constitute the basic shapes of the world's scripts. I cannot see how this is alphabetocentric, as these are truly the bare essentials of all basic shapes as shapes of scripts such as Chinese (consider the basic strokes), Arabic, Thai, Korean Hangul, etc. also consist of them, and these scripts are not used for alphabets.

central unit of graphetics in general. In the assumption of such a unit, 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 a comparative concept applicable to all types of writing systems (cf. Meletis 2019), the grapheme is defined as a semiotic sign constituted by a visual unit—as its *signifier*—and a linguistic unit—as its *signified*. Both of these units are *parts* of a dyadic grapheme. For this reason, the grapheme cannot simultaneously *be* the visual unit since that is only one part of it. It *is*, however, a visual *sign* relating the visual component with a linguistic component. Thus, when I speak of graphemes, I do not mean material visual shapes, but visual signs which have a linguistic value. In his proposed optimization of a model of the German writing system, Rezec manages to divorce these functions allocated to the grapheme, namely (1) being a visual unit, (2) being the smallest distinctive unit of writing, and (3) corresponding to a phoneme, by assigning the first of these functions to the so-called *basic shape* (originally *Grundform* in German). The basic shape is a material unit. However, at the same time, it is abstract. Essentially, it represents a bundle of visual features that are necessary to visually distinguish a shape from the other shapes in an inventory. As Herrick (1974: 11) stated 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|,[18] for example, is the number of segments they consist of. By contrast, 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|).

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

[18] Graphetic units—*basic shapes* and *graphs*—are enclosed in vertical strokes | |, graphematic units—*graphemes* and larger graphematic units—in angle brackets < > (cf. Berg & Evertz 2018: 190).

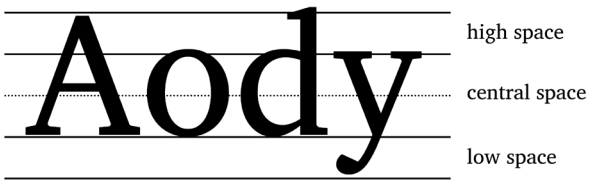

Figure 5. Four-space schema of the segmental/linear space in Roman script (Note: A and o are also basic shapes in the Cyrillic and Greek scripts)

vertically superimposed upon each other (cf. Althaus 1973, see Figure 5).[19] Note that this division was made on the basis of the Roman script and has limited applicability when it comes to other scripts (see below). The topmost of the 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 from the top—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 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|.

Notably, this specific spatial division of the linear space is by no means universal.[20] Quite to the contrary, even if it applies to a number of scripts,

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[19] Alternatively, as visualized in Figure 5 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*) represents 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 by one space, which is called *central space* here (cf. Primus & Wagner 2013: 42).

[20] In an earlier version of this paper, I had included examples from other scripts in the illustration of the four-space schema to indicate roughly that vertical subdivisions exist across scripts. This likely made it seem as if the four-space schema can be straightforwardly applied to these scripts, which was correctly criticized by an anonymous reviewer, whose exact comment I want to reproduce here since it is valuable for a graphetics that attempts to escape Eurocentrism: "You cannot take different scripts and consider that they have similar, or even comparable, 'high spaces' and 'low spaces.' As an example: in Hebrew the *lamed* ל is the only letter with a stroke above the standard height of Hebrew letter graphs, this is so special that there exist situations where this vertical stroke is bent to become horizontal. Therefore what you call 'high space' for

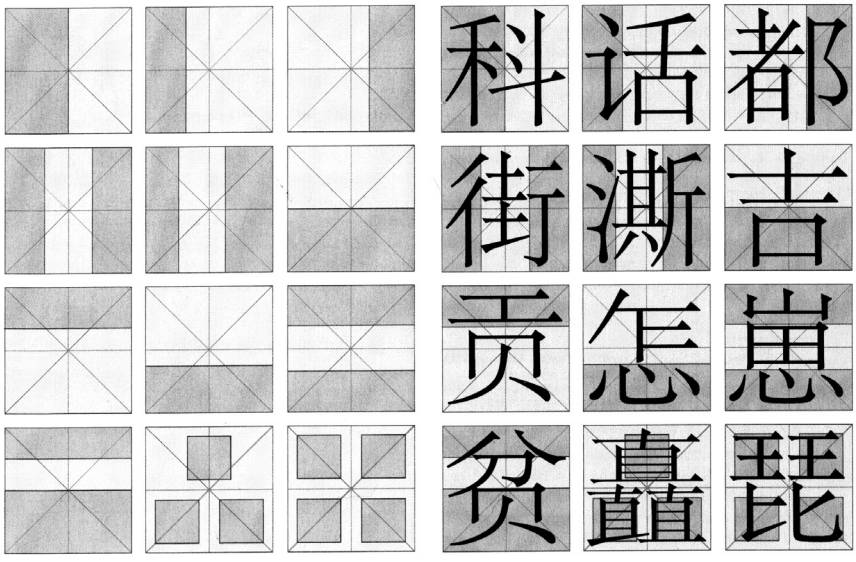

Figure 6. Subdivision of segmental spaces in Chinese script, from Palmer (2015: 32–33)

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 6) depending on how the subsegmental elements of basic shapes are arranged.[21] Because of

Hebrew letters is exceptional, while for Latin capital letters it is mandatory: comparing the two makes no sense. Furthermore, when we use Latin and Hebrew together, Hebrew letters are ***never*** typeset in the same height as lowercase Latin letters (the so-called 'x-height') as the figure seems to imply. The same remark applies to Thai. As for Arabic, the *tha* letter has a height which is shared by many Arabic letters, so it can easily be higher than 0.6 times the Latin x-height" (emphasis in original).

[21] Another difference between scripts is that segmental spaces within a script do not have to be of equal width: In prototypical typefaces that materialize Roman script, for example, the widths of segmental spaces vary according to the sizes of basic shapes that occupy them. |i|, thus, occupies a narrower segmental space than |o|. This is mainly due to a typographic strategy referred to as *kerning*, where the horizontal distance between basic shapes is adjusted as to appear even. This is not the case in so-called *monospaced* (or *fixed-with*, *non-proportional*) *typefaces* of Roman script (such as `Courier New`) where each basic shape is assigned an equal amount of horizontal space, i.e. all segmental spaces are of equal width. This is also the prototypical situation in the scripts of Japanese and Chinese, for example, where basic shapes—regardless of their complexity, which includes the number of strokes—occupy segmental spaces of equal size.

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 combination to form basic shapes—is beyond the scope of this paper, but it is an endeavor that will need to be dealt with in detailed analyses of diverse scripts and writing systems.

So far, only units that different *scripts* (Roman, Chinese, Japanese kana) offer as basic shapes were mentioned. 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) categorizes as *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 mentioned units should be regarded as basic shapes. The question, now, is how it can be established that they belong to different classes. As was argued elsewhere (Meletis 2015: 124f.), visually, there is no clear way to distinguish them: by simply visually describing individual basic shapes such as |Z| and |2| and |§|, one cannot *see* that they belong to different classes. While individual basic shapes cannot easily be categorized, their classes can be evaluated with the help of a mixture of graphetic, graphematic, and graphotactic features, as Bredel (2011: 9) has suggested. Her proposal pertains specifically to the German writing system and makes no claims whatsoever to universality; it is, thus, unsurprisingly not readily applicable to other writing systems. However, it can still serve as a valuable example and starting point for similar future endeavors for other scripts.

Bredel proposes five features for the distinction of different classes of segmental graphetic material that is used in the German writing system, namely 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) *additivity* (cf. Table 1). (1) Context-free identification is a graphetic feature, as it can be determined visually, (2) recodability is a graphematic feature, as it involves the linguistic units that basic shapes are in relations

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	+	–	–	–	–	–

with, (3) combinability is a graphotactic feature, and (4) paired variants is, depending on the view, either graphematic, since there is often no visual similarity between upper- and lowercase basic shapes (e.g. |A| and |a|) and they are just paired according to the linguistic units they refer to, or it is conventional, when the pairing of corresponding upper- and lowercase basic shapes is treated as a convention. (5) Additivity is also a graphetic feature; it characterizes diacritics, i.e. smaller and dependent segments of basic shapes which attach on them within a single segmental space.

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 feature that punctuation exhibits is that it is identifiable without context.[22] It does not display any of the other features: it is not verbally recodable, which means it is usually not 'verbalized' or 'read' the way the grapheme <b> can be read as [b] or the special character <%> can be read as [pɜɹ'sɛnt].[23] Furthermore, punctuation marks cannot combine with each other—the ellipsis <…> is interpreted as one mark,

[22] Note that, as an anonymous reviewer correctly notes, it might not always be the case that punctuation is identifiable without context: take the comma, which (most often) shares its shape with the apostrophe. Without a context, it cannot be evaluated in which vertical subspace of the linear space the shape is located and whether it functions as a comma or an apostrophe.

[23] 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 of the possibilities of writing genderwise correctly in German, e.g. in <Student/innen>, which is to be read as <Studenten *und* Studentinnen> 'male students *and* female students,' where the slash is verbalized as the conjunction *und* 'and.'

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,[24] whereas punctuation marks are not. Again, it is crucial to note that these features have not been tested for the graphetic module of writing systems other than German, but it is expected that they hold for all alphabetic writing systems that have a case distinction, i.e. distinct upper- and lowercase inventories.

I argue that terms such as *letter* or *character* are not appropriate when used as designations for language-specific graphemes. *Letter* is currently being used in this way for the basic units of many writing systems, not only for alphabets, but also for abjads (for a typology of writing systems, cf. Daniels 2017), while *character* is strongly associated with the units of the Chinese writing 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. Meletis 2019). Instead, terms such as *letter* and *character* are reasonably conceived of as graphetic terms that by convention designate classes of basic shapes in certain scripts. For some scripts, there might not even be terms comparable to *letter* or *character*, which is when the general *basic shape* proves useful. Due to the lack of a universal heuristics that allows distinguishing different classes of basic shapes across writing systems the way Bredel's (2011) above-mentioned criteria allow for German and related systems, I argue that what is vital for an analysis across systems is knowledge about the different classes that works *top-down* and thereby allows categorizations (cf. Meletis 2015: 124f.). In other words: When readers and writers are proficient in a writing system, they *know* what class a given basic shape belongs to because they know which linguistic unit it corresponds with and in which contexts it is used.[25] As there is usually no overwhelming systematic visual

[24] 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 the class of digits from the class of 'letters.'

[25] 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

coherence within the shapes of the classes to tell the classes apart,[26] this knowledge is predominantly *graphematic*. To summarize, *basic shape* is generally an underspecified term that designates, at an abstract level, all visual units used in a writing system. However, since this paper is primarily concerned with basic shapes of the type *letter* or *character*, i.e. basic shapes that are the visual components of a writing system's prototypical graphemes, my unmarked use of *basic shape* is restrictive and means only them. A possible, though flawed specific term could be *scriptual basic shape*,[27] 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—especially punctuation marks—are used across many writing systems regardless of the scripts (Roman, Cyrillic, Chinese) employed in these systems.

While the assignment of basic shapes to classes is not a visual, and thus, not a graphetic matter, the differentiation between different individual basic shapes is. Thus, |F| and |E| are different basic shapes mainly for the reason that they differ visually, and not because they usually refer to different linguistic units and therefore, are parts of distinct graphemes (but see below for |T| and |Γ|). Vice versa, visually distinct and thus separate basic shapes such as |ς| vs. |σ| can be assigned to the same grapheme—in this case, the grapheme <ς/σ> which in Greek refers to the phoneme /s/.

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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*.

[26] 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|. Each inventory that has existed for a longer period of time and that has had time to develop usually exhibits a certain degree of systematicity (cf. Watt 1983).

[27] This term highlights the fact that these basic shapes are elements of a *script*, a (most often) closed inventory. It is more general than the script-specific designations *letter*, *character*, etc. It also avoids mixing the linguistic and the material levels, which not only the script-specific designations but also alternative proposals such as *graphematic basic shape* do. However, it is an undeniable fact that these scriptual basic shapes are the ones that are used to embody the default 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,' i.e. closed inventories of visual shapes. However, these sets or 'scripts' in the broader sense are not constitutive of writing systems.

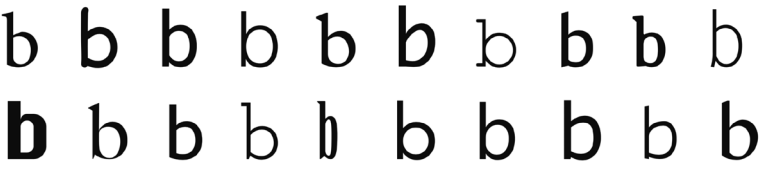

Figure 7. Basic shape |b| materialized by twenty different graphs in different typefaces

|ς| and |σ| are allographs of a grapheme,[28] but they are still distinct basic shapes (and not just different graphs, see below) (cf. Meletis 2020b). Thus, it is the abstract visual information stored in a basic shape—as a visual common denominator—that is distinctive.

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 7). 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. 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 located within the respective 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 grapheme needs to have as its visual component a basic shape. In

[28] An anonymous reviewer argues that |σ| and |ς| are different graphemes: "[…] they are never interchangeable. <φίλος.> and <φίλοσ.> are different graphemic sequences and represent different meanings: the first one means "friend" and the second one "philosopher" (or some other abbreviated word starting with φιλοσ- like φιλόσοφος, φιλοσοφημένος, φιλόστοργος, etc.)." Crucially, <φίλος.> and <φίλοσ.> is *not* a minimal pair, since <φίλοσ.>, as an abbreviation (as indicated by the obligatory abbreviation period, which is superfluous in <φίλος>, which is a complete word), is not a word, only part of a word. |σ| does not occur word-finally in actual words. And it is precisely this fact that they are never interchangeable (and graphematically represent the same linguistic unit, /s/) that renders them a classic case of complementary distribution—and allographs of one grapheme (cf. Meletis 2020b for a detailed description of allography).

Figure 8. Geometrical vs. topological distortion of a prototypical basic shape, from Meletis (2015: 164)

some cases, it has more than one possible visual component, as is the case for above-mentioned Greek <ς/σ> which is visually represented by |ς| and |σ|. A basic shape, in turn, at the level of the concrete realization of writing, needs to be materialized by graphs. Thus, while the basic shape is an abstract and to a degree theoretical unit, the *graph*[29] is its concrete material instantiation (cf. Adam 2013). Every graph is a unique physical event. Also, every graph is always an *allo*graph, as it is only one of countless possible realizations of the same basic shape. As it represents the concrete visual level, the graph level is the scope of all visual variation in writing. And as Ludwig (2007: 382) observes, there are (seemingly) no limits to this variation. Indeed, as long as the abstract visual features of a basic shape—most importantly the number of segments, their arrangement in space and their topological configuration with respect to each other—are kept relatively constant, everything else can vary.

To illustrate this, consider Figure 8, in which the basic shape |A| is materialized as a prototypical graph (left) and in 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|.

In analogy to Neef's (2005, 2015) *graphematic solution space*, in which different spellings for phonological strings (and, in an extension of the concept to morphographic writing systems, morphemes) are located, I propose a *graphetic solution space*. The licensed variation manifested by graphs that are assigned to the same basic shape is located *within* the boundaries of a basic shape's graphetic solution space. Thus, the graphetic

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

solution space is the descriptive 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." Even if a person *is* aware of the individuality of graphs within the graphetic solution space, the differences are non-distinctive at the level of basic shapes and, in turn, graphemes.

An issue central to the graphetic solution space is the investigation of differences between graphs, and an evaluation of how much given graphs differ. As established, 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 said 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 entire 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, i.e. they are used to refer to different linguistic units (the phonemes /t/ and /ɣ/). 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 9 for the graphetic solution space of |T| in Greek). In the latter, the basic shape |Γ| does not exist, and thus, 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 by purely graphetic means, as what is visually distinctive relies on what is graphematically distinctive. Furthermore, a given feature might be distinctive in some instances in a script used by a specific writing system 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. |T| and |Γ| in Modern Greek. The length and/or position of

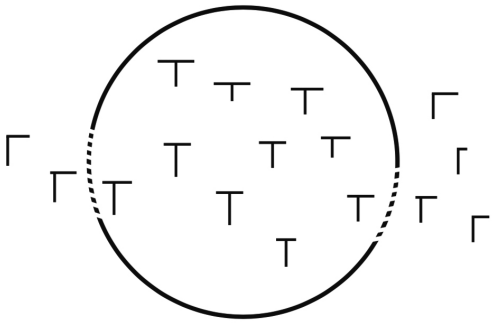

Figure 9. Graphetic solution space for |T| in Greek

the upper stroke is distinctive in this case, but these same features might not be distinctive in any other two basic shapes of the same script.

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, at the 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| in writing systems that use Roman script. In this case, there is a visual distinction between two basic shapes. This distinction might be hard to perceive for users given that they *know* that these two shapes both 'signify' the same, which, in linguistic terms, means they represent the same linguistic unit.[30] When asked, users (in this case of English) often do not even know that two variants exist (cf. Wong *et al.* 2018). Here, the visual distinction does not correspond to a graphematic distinction. However, because of the visual dissimilarity, and possibly also 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.

[30] An anonymous reviewer noted that the two shapes have distinct values in IPA (which is, arguably not a 'writing system' in the narrow sense as established in Section 1 as it does not represent a given language system but is rather a notation system for the faithful transcription of the sounds of *any* language). While they are no longer used distinctively in IPA, it is accurate that they did once have different values. This underlines that a visual distinction such as the one between |g| vs. |ɡ| may be graphematically non-distinctive in one system (such as English and other writing systems using Roman script) and distinctive in another (such as IPA – in the past).

Note that what has been said so far 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). Larger contexts will be addressed in the next section.

When basic shapes (or better: concrete graphs) are produced next to each other, each of them occupies its own segmental space,[31] and they are written in a row, whether horizontally from left to right or right to left or vertically from top to bottom (or, very seldom, bottom to top). These 'rows' lead to the first polysegmental level of writing: the linear space, which is at the center of mesographetics.

4.2. Mesographetics: one-dimensional graphetic sequence, line

Two graphetic units occupy the linear space and are studied by *mesographetics*. They are distinguished from each other in that they are constituted by different empty spaces. Also, the first of them fills only part of the linear space while the other fills all of the available linear space: the first is the *one-dimensional graphetic sequence*, the second the *line* (which is, technically, just a special case of a one-dimensional graphetic sequence in which all or at least most of the linear space is occupied). 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 the type of linguistic unit (morpheme, lexeme, phrase, etc.) that is being visualized, the line is a purely graphetic unit, with only few exceptions.

The one-dimensional graphetic sequence only exists in writing systems in which there are spaces either between words[32] or syntactic

[31] 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.

[32] Previously, in a script-graphetic analysis of the visual material used in the German writing system, this unit was referred to as 'graphic word' (cf. Meletis 2015: 130–132). This is problematic since, on the one hand, it mixes the graphematic and the graphetic levels of description. Even if the one-dimensional graphetic sequence commonly corresponds with 'words' (however one defines this linguistic unit or category), this cor-

units.[33] The latter is the case in Thai, for example, where, due to the lack of empty spaces between words, one-dimensional graphetic sequences visualize and/or are constituted by syntactic units. In all of the writing systems using Roman script or a modified version of it, the one-dimensional graphetic sequence usually makes words graphematically discernable. However, it is crucial to note that a correspondence with the lexical or morphosyntactic definitions of 'word' or 'sentence'—whatever these may be in a given context—is not required for the definition of the one-dimensional graphetic sequence, which is an entirely independent graphetic unit: everything that stands between two empty spaces of this level (the most common empty spaces) and consists of at least two basic shapes (i.e. occupies at least two segmental spaces) regardless of their class qualifies as a one-dimensional graphetic sequence.[34] This means that in alphabets, basic shapes such as, for example, punctuation marks—whether at the word-level such as <'> or at the sentence-level such as <!>—which are enclitically attached to other basic shapes, are parts of one-dimensional graphetic sequences. Thus, at the end of the preceding sentence, |sequences.| (highlighted in gray) is a one-dimensional graphetic sequence, and in the preceding phrase, |sequence,|

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respondence cannot be constitutive of 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 correspondences—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.

[33] An anonymous reviewer asks whether there are no one-dimensional graphetic sequences in Chinese, which does not exhibit spaces between words or syntactic units. There are not, in fact, as there are no blank spaces (i.e. empty segmental spaces) within lines, and all lines (except for first lines in indented paragraphs, final shorter lines of paragraphs, etc.) are fully filled with written material. However, as argued here, lines are only special instances of one-dimensional graphetic sequences characterized precisely by the fact that they occupy the entire linear space as opposed to only part of it.

[34] This corresponds with the rough definition of the graphematic word proposed by Fuhrhop (2008: 193, my translation): "The graphematic word stands between two spaces and does not contain any spaces internally." However, while this purely graphetic definition suffices for the one-dimensional graphetic sequence, a number of additional criteria determine whether a string located between two empty spaces classifies as a graphematic word (cf. Fuhrhop 2008: 194).

is a one-dimensional graphetic sequence. Visually, in these cases, there are no larger spaces between basic shapes and punctuation marks than there are between a basic shape and a different basic shape. Note that these units are not graphematic words as defined in German grapholinguistics, as (sentence-final) periods and commas are, unlike punctuation marks at the word level such as the apostrophe and the hyphen, not regarded as parts of graphematic words (cf. Fuhrhop 2008: 217, Evertz 2016: 391). One-dimensional graphetic sequences and graphematic words are also incongruous in cases in which graphematic words consist of only 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, not one-dimensional graphetic sequences. They are, however, graphematic words.

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 a physical boundary, often the edge. Reaching this edge commands that one continues writing a little bit below (in horizontal top-down writing systems) or to the left of (in vertical right-left writing systems) the last line. 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 also only occupy 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[35] 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.

[35] Ludwig (2007: 377) notes that in the past, the tasks of writing and designing texts 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. Authors who hand in manuscripts of their books to publishers, 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.

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

When linear spaces are concatenated either horizontally or vertically, but necessarily in the different dimension than the respective concatenation of segmental spaces to form linear 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 typically 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 (i.e. paragraphs at the bottom of the page in smaller print) and maybe a figure or a table are printed, as is the case in this paper, 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, the latter of which are often perceived simultaneously when reading a book, but any writing surface that can be perceived at once. This can also be the section of a website that is currently displayed on a screen, but also a wall on which Powerpoint slides are being projected. When scrolling up or down or pressing a key, the holistic space in these examples changes. In this sense, holistic spaces are dynamic and determined by what is presented to perceivers as a "whole" space. The printed page is only the prototypical analog version of the holistic space.

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 perceiver to identify the genre of a text, it functions as a

graphetic dispositif. If a text is designed rather prototypically, i.e. its elements are arranged in a way typical of a genre, it should be 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 10). What counts and works as a graphetic dispositif is, of course, utterly culture-specific and in general determined by an abundance of other factors (epoch, region, familiarity of a genre, etc.).

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 or numbers, what is crucial for the distinction between lists and running texts is how much of the linear space is filled: just the left list space, or does the text run beyond that? Accordingly, 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 gradual 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. Reißig & Bernasconi (2015: 235) empirically test the perception of these graphetic dispositifs and arrive at the conclusion that with the decreasing length of lines, i.e. the decreasing occupation of the linear space, readers decide in favor of the list mode. Not

Figure 10. Graphetic dispositifs of a recipe (left/middle) and a newspaper front page (right)

only does Reißig's contribution 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.

4.4. Paragraphetics

Micro-, meso-, and macrographetics treat all 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. Since 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, can be re-termed *paragraphetics*. Stöckl chooses the prefix *para-* for this level because the aspects of writing treated by paragraphetics 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), grey-scale 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 the 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."[36] If, for example, 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 and shows that contrast/lighting, resolution, and flickering are

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

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.

5. Conclusion

Studying writing without acknowledging the relevance of graphetics would be highly ignorant, since writing, as a modality of language, is dependent on a materialization. Without graphetics, there is no writing. Yet, this particular branch of the study of writing is heavily underdeveloped and underserved in grapholinguistic research. At least it appears that way on the surface. The absence of the term *graphetics* in the literature—even grapholinguistic literature—ought not distract from the fact that questions pertaining to the materiality of writing *are* indeed studied. However, the relevant research is scattered across disciplines. Due to the lack of a shared conceptual and terminological framework, promising findings from the multiple disciplines interested in graphetic concerns are not designated as *graphetic*, and consequently, they are not exchanged or circulated beyond disciplinary boundaries, and that is precisely what keeps a grapholinguistic discipline *graphetics* from becoming established. As a term and as an idea, graphetics could be the center of an interdisciplinary endeavor, the glue that holds all research on the materiality of writing together. Therefore, I advocate classifying graphetic research as such (at least additionally), no matter which discipline it originates from, with participating disciplines being as diverse as art history and psychology. In the end, graphetic art historic and graphetic psychological research obviously share a common denominator: the materiality of writing.

However, designating highly diverse graphetic research as such will not suffice for the establishment of the discipline. What is also central is the negotiation of categories and concepts as well as methods at the core of the discipline. The present paper represents a step in that direction. It highlights spatiality as the main governing principle of the materiality of writing and of writing in general, setting the written modality of language apart from the spoken modality which is governed by temporality. The spatial features of writing resulting from such an analysis can be studied across writing

systems and the various scripts they employ and, in some respects, exhibit a degree of universality that transcends the more specialized language- or type-specific graphematic features of writing. Also, describing how the units of writing are spatially arranged at various levels is not merely a descriptive endeavor but opens the door for the comparison of visually diverse scripts and supports the operationalization of signal graphetic questions that address how units of writing are processed in production and perception. Since the materiality of writing is, unlike graphematics, independent of given languages, graphetic universals can be studied; they are expected to contribute to a better general understanding of how writing works.

This conceptual proposal is a reintroduction of the field of graphetics insofar as it presents valuable existing graphetic research of the past—and builds upon it. Along with a rough spatial framework, it offers both a starting point for future graphetic research and a background against which existing graphetic research can be systematized and integrated into a larger theoretical framework. In the course of the establishment of the discipline, the present proposal and framework will imperatively need to be modified and updated.

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