Prosodic Structure in Munster Irish

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Connor McCabe, 23 August 2022

Summary

This thesis centres on prosody (rhythm, intonation, and prominence) in the Munster varieties of Irish (Gaelic). Munster Irish (MI) is distinct from other varieties of the language in having a complex, weight-sensitive system of prominence-assignment in words of more than one syllable described for it. This sets it apart from the system of word-initial prominence found in other varieties, present and historical. The phenomenon has been suggested to derive from misalignment between high pitch and metrically strong syllables. MI intonation itself has received comparatively little systematic phonetic treatment in contrast to the varieties of Donegal and Connemara. Munster Irish has also received considerable attention in formal phonological literature because of the particular intricacies of the lexical prominence system as typically described.

Over four chapters of instrumental phonetic and statistical analysis of acoustic data, I address three research questions. The first interrogates the rhythmic and weight status of word-initial syllables in MI, and how these may be affected by initial mutation. This uses data from a metronome-synchronisation experiment run with 14 L1 MI speakers recorded remotely in 2020-21. The second asks whether phonetic measures of syllable prominence align with traditional descriptions, and whether speakers consistently produce such patterns independent of lexical knowledge. This uses naturalistic data from both the 14 2020-21 speakers and 20 L1 MI speakers recorded in 1928 (wax-cylinder recordings digitised and freely available online via the Doegen Records Web Project), as well as controlled data collected in a nonword production experiment with the 2020-21 speakers. The third question asks how high pitch aligns with metrically strong syllables at phrase level, using intonation data from the aforementioned naturalistic recordings for an analysis based on F0 turning points.

The issue of synchronic variability across MI subvarieties, and change between 1928 and 2020-21 is also addressed for both lexical prominence and intonational alignment. The 1928 data are roughly contemporary to several foundational descriptions of MI, including its prosody; to my knowledge this represents the first instrumental phonetic examination of these historical data.

The main findings can be summarised as follows. Results of the metronome experiment do not provide evidence for a strong link between mutation and initial syllables' weight status, although the experiment was interfered with by the change to remote data-collection forced by the COVID-19 pandemic. The investigation of lexical prominence proceeded via 28 Bayesian mixed-effect models examining intensity, pitch height and range, vowel duration, and (for the nonword data) vowel height and backness as a function of syllable position across various weight structures. Results broadly indicate a mismatch between intensity- and pitch-prominence. There is support for limited application of intensity-prominence to non-initial heavy syllables, but no support for the controversial medium-heavy weight status often attributed in the literature to the sequence /ax/ once certain high-frequency light-/ax/ lexical items are controlled for. Regarding alignment of high pitch, there is robust evidence of heightened F0 occurring outside of metrically strong syllables in some speakers, while others show closer alignment between the two; subgrouping along regional lines is robustly evident. For both lexical-prominential and phrasal-intonational results, there is variability between contemporary speakers/regions, and clear change within regions between 1928 and 2020-21.

The implications of this are substantial. Subregional variability suggests that small samples from individual subvarieties should not be taken as representative of ‘Munster Irish’ as a whole in any era. Further, robust change between 1928 and 2020-21 encourages caution in treating present-day data as implicitly compatible with century-old impressionistic dialect descriptions. It is hoped that this will set the stage for future experimental- and instrumental-phonetic research on Irish varieties.

Lovingly dedicated to the memory of my father, Michael McCabe (1973-2022),
and of his grandfather, George Marmar (1926-2013).

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1 INTRODUCTION

This thesis examines prosody – rhythm, intonation, and prominence – in the Irish (Gaelic) varieties of Munster, the southern of Ireland's four historic provinces. At present, there are Munster varieties spoken as traditional, historically continuous community languages in small pockets of Counties Kerry, Cork, and Waterford. Until relatively recently, Counties Clare and Tipperary also had traditional speaker communities, but these did not survive into the 21st century. The remaining three regional subvarieties are arguably the most vulnerable out of the various Gaeltacht varieties still spoken in comparison with those of Connacht and Ulster.

There are several reasons for having undertaken this work. In an Irish-specific sense, instrumental phonetic research on Irish prosody is still in many ways underdeveloped, and this is particularly true of the Munster varieties. Until the early 2000s, prosodic coverage in treatments of Irish varieties was limited to impressionistic sketches of 'typical' intonation patterns as part of dialectological descriptions, which typically devoted more space to highly detailed coverage of segmental phonology, and to 'stress' and/or 'accentuation' (e.g. O'Rahilly 1932, Ó Cuív 1944, Breatnach 1947, discussed in Chapter 3).

Beginning with the 2003-2006 Prosody of Irish Dialects project[1] in the Phonetics & Speech Laboratory of Trinity College, Dublin, the former gaps in intonational study began to be addressed: instrumental acoustic analyses were carried out on recorded data collected under controlled conditions in order to systematically describe intonation in modern Irish varieties. PhD projects in the subsequent decade undertook general surveys of cross-regional intonation (Dalton 2008; O'Reilly 2014), and more targeted study of microvariation within regions (Dorn 2014). In these studies, the Munster varieties consistently received the least attention, not for want of thoroughness so much as for a variety of practical considerations. Dalton's (2008) doctoral study, and related conference papers, included informants from West Kerry to represent Munster, and in my own MPhil thesis of 2018, I undertook to provide an intonational study of the Munster subvariety of County Waterford (spoken in the villages of An Rinn and An tSean Phobal). This leaves only the variety (or, indeed, varieties) of West Cork as having not yet received some form of acoustic-phonetic investigation of intonation (and other prosodic features). Thus, there was a pertinent gap in the literature with regards to a systematic, pan-Munster study of prosody.

There is, however, a more general linguistic perspective from which Munster prosody is of interest. These varieties traditionally have a complex lexical prominence system attributed to them, with

[1]Supported by the Irish Research Council for the Humanities and Social Sciences, 2003-2006; Principal investigator: Ailbhe Ní Chasaide.

dialectological references to the region's 'stress' and 'accentuation' – a terminological minefield into which I refrain from venturing until Chapter 2 – stretching back through the 18th century. In brief, unlike the strong default in modern Connacht and Ulster Irish (as in Old and Middle Irish) for the first syllable of a word to be the most prominent, Munster varieties are described as having non-initial prominence in various classes of words containing long vowels or the sequence /ax/ in second or third position. The particular circumstances under which this non-initial prominence obtains have attracted the attention of formal phonologists (e.g. Doherty 1991, Green 1997, Bennett 2012, Iosad 2013, Windsor 2017) with an interest in general theories of metrical structure and prominence-assignment beyond linguists more directly interested in Irish dialectology – by no means a hard divide, of course. In the course of this, Munster lexical prosody has been marshalled as evidence in favour of particular theoretical claims regarding linguistic universals in metrical structure, phonetic and phonological bases for the concept of syllable weight, and the place of 'extrametricality' in theories of prominence.

In addition to rule-based and Optimality Theoretic treatments of ostensible prominence assignment in present-day Munster varieties, the historical origin of this phenomenon (sometimes termed 'forward stress') is also a topic of considerable interest. Analogical lexical spread via an influx of loanwords and prolonged multilingualism in the region has been suggested, particularly with reference to Norman French (associated most strongly with T.F. O'Rahilly 1932). Virginia Blankenhorn's (1981) suggestion, on the basis of experience with Welsh intonation and the formal study of pitch-accent structure and alignment, that late-aligned high pitch could have been reanalysed as right-shifted lexical prominence has been particularly influential. More recent instrumental work (Windsor *et al*. 2018) has identified mismatches between intensity- and pitch-prominence in limited data from Munster speakers, where coordination between these two phonetic domains is attested in neighbouring Connacht.

The phenomenon and its various treatments are discussed in some detail in Chapter 3. For the purposes of framing the present work writ large, what is relevant is that prominence placement in Munster Irish words has attracted a surprising amount of attention for a highly minoritised language variety spoken only in small pockets of southern Ireland. More interesting still is that, as returned to in Chapters 3 and 5, the bulk of this theoretical work has been based on impressionistic dialectological descriptions couched in ambiguous terminology. The problem of acceptable 'data' for these types of theoretical claims is explored in Chapter 2.

In the remainder of this introductory chapter, I outline the chronological development of the present work before providing a brief description of each subsequent chapter and their relationship to one another.

1.1 Chronological development

Over four years of study, my research interests and goals have evolved considerably. Originally, my primary interest was in the systematic description of intonation in the region, looking at pitch-accent inventories and tonal timing across the subvarieties of Kerry, Cork, and Waterford. As part of this, it was envisaged that a Blankenhorn-type theory of right-deferred high pitch which could have plausibly been reanalysed as right-shifted lexical prominence could be evaluated.

Additionally, the prosodic and metrical behaviour of initial syllables was a matter of interest. Previous treatments of lexical prominence in the region have at times suggested that initial syllables are somehow variably ‘extrametrical’ or ‘defective’ for the purposes of the construction of metrical feet and/or reckoning of syllable weight; Iosad (2013), for example, suggests ‘weight-sacrificing recursion’ to account for non-initial prominence in the case of competing heavy syllables in initial and peninitial position. To my mind, there was a natural avenue of investigation into this apparently unusual behaviour of initial syllables and a typologically rare Irish morphophonological process which affects the segmental makeup of these same initial syllables: *initial mutation* (see discussion in Chapter 3). This began as a broad concept involving the behaviour of prosody in the context of initial mutation, including the possible prosodic differentiation of mutation-derived homophones, and quickly developed into a study of perceptual rhythm surrounding *P*(*erceptual*)-*centres* (Chapters 2 and 4). The latter have been linked to gradient effects involving syllable weight, and are known to vary as a function of syllable segmental composition and – possibly – morphological derivation.

With this line of thinking in mind, I carried out a small pilot study in the summer of 2019 to explore the relationship between initial mutation and prosody. Data were collected from three native speakers of Waterford Irish in a metronome synchronisation task (to look at P-centres) and a sentence reading task (to look at intonation/alignment). As detailed in Chapter 4, only a limited subset of the results of this pilot were of any particular interest, involving P-centre alignment apparently based on targets’ lexical identity rather than segmental makeup (mutation-derived or otherwise). The intonation portion of the pilot revealed no salient patterns in alignment differentiating mutation-derived homophones. Subsequently, it was planned to carry out a scaled-up version of the metronome synchronisation task with revised, simplified stimuli to more robustly investigate the relationship between mutation, perceptual rhythm, and segmental features. The aim of this was to shed light on prosodic structure in modern Munster Irish varieties, while also examining factors that could have caused the prominence shift so characteristic of the macrovariety.

Just as this main phase of P-centre data collection was getting underway, the COVID-19 pandemic indefinitely interrupted fieldwork in the Gaeltachtaí, and I was left in a holding pattern midway through the second year of the PhD (spring of 2020). While waiting to resume planned data collection, I decided to investigate archived recordings from 1928 held by the Royal Irish Academy (the Doegen Records), which are freely available online. This was done, frankly, without clearer or more specific aims than exploring data from a more conservative era for the language. I began phonetically annotating storytelling recordings at the syllabic and segmental levels, and marking intonational events of interest (especially any apparent cases of rising pitch-accents in contrast to the falls described as a strong regional default). Over the course of these preliminary annotations in the spring and summer of 2020, I realised that I was identifying a surprisingly large number of ambiguous prominences at the lexical level, particularly cases in which increased intensity aligned with initial syllables, while heightened pitch occurred on a later syllable. Most notably, this frequently emerged in items described as having ‘shifted’ non-initial prominence in Munster. These ambiguities are treated in detail in Chapter 5; for the purposes of this chronological outline this is simply relevant as a turning point in my approach to this research enterprise.

By the beginning of my third year in September of 2020, I was confident that a study of Munster prosody which skipped a critical investigation of lexical-level prominence in the region in favour of a straight-to-phonology approach to intonation and rhythm was neither tenable nor desirable. This was due to my newfound scepticism of previous descriptions of lexical prominence in Munster, including the categorical application of ‘stress shift’ in even simple cases of light-heavy disyllables, and the productive medium-heavy status of /ax/ (see Chapter 3). Equipped with this, and having decided to accept online data collection rather than wait for the relaxation of public health restrictions in the short-to-medium term, I consolidated a plan for the thesis closely resembling its present form.

Between December of 2020 and July of 2021, I collected data on lexical and phrasal prominence in Munster Irish varieties in 1928 and the present day. In continuity with my pre-pandemic approach, participants in online interviews completed a metronome synchronisation task in order to investigate P-centre location, syllabic and segmental features, and initial mutation. A nonword production experiment was run as well, with the aim of interrogating default prominence patterns across stimuli controlled for syllable composition and weight structure, relatively independent of speakers’ lexical knowledge. Finally, participants read and retold a short story to provide naturalistic data for analysis of real-word lexical prominence and intonation. The data from this final task were explicitly intended to be compatible with the archival data available from the 1928 Doegen Records, which comprise storytellings. Statistical analysis of rhythmic and prominence data in Chapters 4-6 have been undertaken using Bayesian methods, rather than the frequentist ones more common to date in linguistic research. The reasons for this, and relevant methodological and interpretative details, are provided in these chapters as needed.

In summary, the above describes the organic development of the present research enterprise as my familiarity with the literature and relevant data evolved, in interaction with ambient circumstances (particularly the global public health crisis caused by COVID-19). What began as an investigation of intonational alignment and initial mutation has turned into a multipronged, bottom-up approach to prominence in Munster Irish varieties at the lexical and phrasal levels. Each of the four component analysis chapters (Chapters 4-7) address distinct research questions (RQs). These questions and their associated rationales and hypotheses are laid out in Section 1.2 below.

1.2 Layout of the thesis and research questions

The remainder of this thesis is structured as follows. In Chapters 2 and 3, general background information is presented on prosody and on Irish, respectively. These have been ordered such that pertinent controversies and gaps in phonetic/phonological work on Irish prosody (Chapter 3) can be discussed in light of language-general concepts outlined in Chapter 2. Within these background chapters, subtopics are allotted space and focus proportionate to their relevance (e.g. far more time is spent in Chapter 3 examining Irish suprasegmental phonology than word order or phrase structure).

Chapter 4 then presents the previously mentioned metronome-synchrony study of P-centres and initial mutation, challenges in its adaptation for remote data collection, and the extent to which its outcomes are informative. This chapter addresses RQ1 (below), the context for which is laid out in Chapters 2 through 4, as relevant topics in speech rhythm, morphophonology, and Irish are presented. Essentially, this examines the relationship between a characteristic Munster Irish feature (a shift in prominence away from initial syllables) and a cross-linguistically rare phenomenon found in the Celtic languages (initial mutation). The examination is approached based on reported evidence of morphophonology influencing the location of P-centres in segmentally identical homophones.

> **RQ1:** Does initial mutation contribute to the apparent phonetic/phonological instability of word-initial syllables in Munster Irish (MI)?
> ***Hypothesis:*** Duration of onsets is unaffected by mutation, while syllable rhymes are affected. The latter makes initial syllables unstable for weight-reckoning purposes within individual lexical items.

RQ1a: In terms of P-centre location, do mutated items align with their unmutated/radical counterparts, or with their segmental matches?
Hypothesis**:** Mutated items align with their lexical matches, rather than with their homophones (e.g. the P-centre of *bpá* matches that of *pá*, not that of *bá*).

Chapter 5 then moves into the area of lexical prominence, examining intensity-, pitch-, and duration-based measures of prominence across syllable positions in di- and trisyllabic lexical items of various weight-structures in the available naturalistic data from 1928 and the present day (RQ2). This interrogates received descriptions of lexical prominence in Munster, and lays the foundations for future work by systematically analysing prominence in multiple phonetic parameters (e.g. intensity, pitch, and duration) across syllable positions in words of various weight structures. There is a further question of pan-Munster uniformity, given the tendency to treat the region's purported lexical prominence system as monolithic, drawing on limited data and/or descriptions from multiple subregions. This, and the issue of diachronic change over the past century, are addressed in RQs 2a-b. Chapter 6 presents a closely parallel analysis of present-day speakers' production of nonwords (RQ2c).

RQ2: Do any phonetic prominence parameters align with descriptions of lexical prominence/'stress' location in MI?
Hypothesis**:** One or more non-pitch parameters align with unshifted initial prominence (as in Ulster and Connacht), while salient pitch events align with non-initial syllables.

RQ2a: Are lexical prominence patterns consistent across Munster subvarieties?
Hypothesis**:** Regional varieties differ from one another.

RQ2b: Have lexical prominence patterns in MI changed between 1928 and the present day?
Hypothesis**:** 1928 speakers have distributed/ambiguous prominences, while present-day speakers show more straightforward 'shifted' prominence under expected conditions.

RQ2c: Do present-day MI speakers productively produce non-initial prominence in items they have never pronounced before?
Hypothesis**:** Speakers are more likely to show variability in assigning prominence to nonwords than consistent patterns aligning with predicted prominence shifts.

Finally, Chapter 7 presents a preliminary investigation of intonation in the 1928 and 2020-21 data, with majority emphasis on temporal coordination between high-pitch intervals and metrically strong syllables (RQ3), rather than on, e.g., the description of a pitch-accent inventory for the region. This relates to Blankenhorn's (1981) theory of right-shifted prominence in Munster deriving from a historical reanalysis of high pitch on post-tonic (non-initial) syllables as a marker of lexical prominence. The exploratory analytical approach taken to the available data therefore looks at intonation contours in terms of phonetic shape. The phonological specification underpinning these shapes (see discussion of Autosegmental-Metrical phonology in Chapter 2, and related work on Irish intonation in Chapter 3) is not strictly a matter of interest, although it may be for future work using these or additional data from the region. As for Chapter 5, geographic diversity and diachronic change are both of interest (RQs 3a-b).

> **RQ3:** Does high pitch in intonation contours align with metrically strong syllables?
> ***Hypothesis*:** High pitch often occurs one or more syllables following metrical strength.
>
> > **RQ3a:** Is intonation (including alignment) consistent across Munster subvarieties?
> > ***Hypothesis*:** Regional varieties differ from one another.
> >
> > **RQ3b:** Has intonation (including alignment) changed between 1928
> > and the present day?
> > ***Hypothesis*:** Present-day speakers exhibit more influence from English prosody.

The thesis concludes in Chapter 8 with a general discussion of prosody in Munster drawing on results from Chapters 4-7, finishing with directions for future work.

2 BACKGROUND ON PROSODY: THEORETICAL AND ANALYTICAL CONTEXT

Prosody refers to suprasegmental elements of speech, including lexical-level prominence (most commonly termed ‘stress’), rhythm, intonation, and voice quality. These components may be treated separately to a certain extent, but it should be borne in mind that their realisation is in fact often complexly interwoven. The research questions outlined above and explored in Chapters 4-7 address prosody in Munster Irish, and rely heavily on fine-grained details concerning lexical and phrasal prominence, rhythm, and intonation. which are frequently subject to stipulation or glossed over as background information. In order to approach these, this chapter presents background on relevant prosodic concepts before proceeding to discussion of Irish – and the case of Munster in particular – in Chapter 3.

The discussion begins with lexical prominence in Section 2.1, relating to RQ2. The variable location of lexical prominence is arguably the single most defining feature of Munster Irish phonology, setting it apart from the modern varieties of Connacht and Ulster. In order to fully appreciate the critical approach taken to previous descriptions of lexical prominence in Munster Irish (Chapters 5-6) and formal phonological accounts of its productive assignment, it is necessary to first understand the component concepts which discussions of the same entail. Further, prominence at the lexical level is an important and indeed fundamental component in the analysis of other suprasegmental features, including intonation and supralexical speech rhythm. Section 2.2 follows with an introduction to the *perceptual centre* or *P-centre*. This is the foundation of the experiment described in Chapter 4 (RQ1). Section 2.3 then introduces *syllable weight*, relating to both lexical prominence and P-centres, and of particular relevance for the treatment of lexical prominence in Munster Irish. Phrase-level prominence, specifically intonation, is discussed in Section 2.4 as part of the framing of RQs 3a-b and the analytical approach taken in Chapter 7. The chapter concludes with a summary and discussion in Section 2.5.

2.1 Lexical prominence

The concept of lexical-level prominence is one which is fraught with historical vagueness, opaque assumptions, and contradictory terminological definitions. The most common terms in use are ‘stress’, ‘accent’, and compounds derived from one or both. In the interest of clarity, for the remainder of this work I refer to ‘phonological lexical prominence’ (PLP) when discussing the structural phonological characteristic identifying a particular syllable in a word as stronger than its tautolexical counterparts (cf. Gordon 2011), and otherwise refer simply to ‘prominence’ in various phonetic domains (e.g. intensity, duration, and F0). However, an awareness of more traditional terminology for these phenomena is important, not least in order to relate the findings presented in Chapters 4-7 to other work in the fields of prosody and Irish phonology.

2.1.1 Terminological heritage

Regarding the terms 'stress' and 'accent', while it has certainly been the case that individual authors or schools may consistently adhere to well-specified definitional boundaries of one or both terms, such usage preferences may directly contradict one another (Fox 2000: 114). Both have been used to refer to the abstract concept of phonological strength-marking. Syllables so marked are eligible to receive phonetic prominence(s), which may themselves be termed either 'stress', 'accent', or one of a number of hybrid terms, e.g. 'stress-accent' or 'pitch-accent' (van der Hulst 2014). The former may be used to refer to the marking of prominence independent of pitch (e.g. via intensity and/or duration)[2]. The latter variably refers to lexically contrastive alignment of pitch with prominent syllables (as in some varieties of Swedish; Segerup & Nolan 2006) or to phrase-level/supralexical pitch events which 'anchor' to syllables specified as phonologically eligible.

The variable contrast between the referents of 'stress' and 'accent' approach an important truth, namely that prominence(s) can involve more than one domain, including pitch (fundamental frequency/F0), intensity, cepstral peak prominence, voice quality, duration, and vowel quality. However, increased strength in these domains is not universally or articulatorily required to co-occur. In stark contrast to this, there has been a historical tendency to define 'stress' and/or 'accent' offhandedly, anecdotally, and universally as increased prominence in either (i) a single phonetic domain or subset of domains, or (ii) all possible exponents of prominence in concert.

This terminological situation was inherited by modern linguistics from earlier work in classical languages and poetics, perhaps most notably in Greek, Latin, and Sanskrit. I turn briefly below to a discussion of 'accent' and 'stress' in Greek and Latin from Classical grammar and philology. This is by no means exhaustive, and the reader is referred to more thorough explorations of the topic such as that of Allen (1973: 3-26, " 'Prosody' and 'prosodies': the historical setting") for further reference. Although Greek and Latin prosody may appear somewhat tangential to a phonetic study of Modern Irish, I feel that it is important to appreciate the murky origins of our current terminological situation; furthermore, several treatments of the same topic are roughly contemporary to foundational descriptions of prosody in Irish (see discussion of O'Donovan's

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[2]For example, in his *New English Grammar*, the prolific English linguist Henry Sweet defines 'stress' offhand as "loudness" which can occur in three different degrees, and the occurrence of which "makes a new syllable, the beginning of the syllable corresponding with the beginning of stress" (1900: 228-229).

1845 *A Grammar of the Irish Language* and O'Rahilly's 1932 *Irish Dialects Past and Present* in Chapter 3).

Greek exhibits lexically specified and contrastive syllable prominence, although the possible locations for the latter's assignment is restricted by word structure and syllable content (Devine & Stephens 1985); this is true of the long dead Classical and Koiné Greeks, as well as of Modern Greek. In the pre-Modern varieties, partially positionally-conditioned 'pitch-accents' were indicated orthographically via diacritics on vowels (acute accent <´> indicating high pitch, grave accent <`> indicating low, and circumflex accent <~> indicating a rise-fall) introduced sometime around 300 B.C. (Allen 1973: 4). The particular phonological and phonetic nature of this 'accent', however, has historically been a source of some controversy. Contemporary authors referred to the πρωσοδία (*prosodía*) 'prosody' or melodic intonation of words; Hadley (1869-70) distinguishes between the 'key' (pitch) of an orthographically accented syllable as an entirely distinct property to its 'stress' (which he associates with "increased effort of the vocal organs").

This is echoed by Miller (1922) who, referencing Hadley, criticises the tendency to read Greek and Latin with "English rhythmic speech habits". Both authors are concerned not so much with accounting for the location of prominent syllables within words in these languages, as with a phonetic realisation of this property. In this usage, typical of its time, 'stress' and 'accent' are two means of prominence-marking: one 'force' based (typically loudness and duration) and the other pitch-based. The former they associate with reduction of surrounding syllables, while the latter they associate with tonal change independent of any other suprasegmental property. Other have suggested the existence of a 'non-accentual stress' for Ancient Greek which was independent of the location and shape of a word's pitch-accent and which was phonologically predictable (Allen 1973: 274, 283-296). This is related to the concept of the *ictus*, a word or phrase's rhythmic 'centre of gravity' (Miller 1922; Allen 1973: 276-278) distinct from its accentuation, and in Allen's usage would be a 'dynamic', strength-based rhythmic alternation which is 'non-accentual' in the sense of being unrelated to lexical contrast.

In Modern Greek, it is generally accepted that there is a single form of contrastive syllable-prominence at the lexical level, the orthographic representation of which is indicated by an acute accent <´> surviving from the four classical diacritics, and the primary acoustic cues to which are duration and intensity (Revithiadou & Lengeris 2016). The relationship between the latter 'stress accent' and the Classical system is a matter of some controversy (Devine & Stephens 1985), described by Allen (1973: 81) as "independent melodic accent [changing] to stress".

In Classical Latin, by contrast, the location of stress/accent was not lexically contrastive, and its location was strictly determined by rules involving syllable counting and syllable *weight* (Ryan 2014, 2017). The concept of phonological weight is returned to in greater detail below, but can be said to broadly refer to characteristics of a syllable's duration and structural complexity. Culminative syllable prominence at the lexical level was restricted to within three syllables of the right edge of a prosodic word. Further, there is no evidence of the Latin stress/accent sharing the highly tonal character of its Greek counterpart (Hadley 1869-70; Miller 1922; Allen 1973: 151-154; Devine & Stephens 1985). This lexical-level prominence is broadly assumed to relate to relative 'strength', either without or, at the very least, independent of pitch movement. Nevertheless, 'accent' is used to discuss the Latin case as well as the Greek; the pitch versus non-pitch division in usage has never been rigid with any cross-authorial consistency. In reference texts from the turn of the 20th century, the two terms were used practically interchangeably; Gildersleeve and Lodge (1895: 8) explicitly equate the two ("Disyllabic words have the accent or stress on the penult…") and then proceed to use 'accent' as a default, while Grandgent (1907: 61) uses the term 'accent' to refer to the general notion of syllable prominence, realised in Latin by 'stress' (presumably as opposed to pitch) before proceeding on the same page to describe where "accentuation" occurs in a section on "primary stress".

The Latin prominence system – positionally assigned and not tied to lexical-level pitch specifications – is broadly what was inherited by the modern Romance languages (via Vulgar Latin and the medieval proto-, Old, and Middle Romance languages of the former empire), and has been cited as influential on Modern English's departure from Germanic, demarcative, initial prominence (see discussion of competing claims in Fournier 2007). The end-result of the evolution from Latin varies by descendant; Modern French, for example, has weak prominence on final syllables, whereas Spanish has retained a Latin-like three-syllable prominence-domain aligned to the right edge.

Much discussion of classical lexical prominence overlaps with the study of poetic metre, which is often drawn upon as evidence for the evaluation of competing proposals (e.g. in evaluating Allen's 1973 claims about 'non-accentual stress' in Greek; Devine & Stephens 1985). Classical Greek metres were quantity-sensitive, but generally accent-blind (Miller 1922; Devine & Stephens 1985). That is, they were concerned with the number of *feet* of particular syllabic compositions in a given line. Dactylic hexameter, for example – the 'epic' poetic metre of, e.g., the Iliad and the Odyssey – specifies (in its strictest form) lines of six feet, with each foot comprising a *dactyl* (a long/heavy syllable followed by two short/light syllables, so called because of the longer first segment and two shorter end-segments of the human finger; Ryan 2019: 149). Latin metre, on the other hand, was sensitive to both quantity and the position of syllabic prominence within a word (Ryan 2017).

Heavier reference to 'stress' as part of the definitional composition of metre is found in English poetry, for which syllable weight is often immaterial so long as requirements on numbers and spacing of prominent syllables are met (cf. iambic pentameter, famous for its use by Shakespeare – lines comprise five *iambic* [initially-prominent] disyllabic feet).

A thorough exploration of poetic metre, and indeed of lexical prominence in Classical Greek and Latin, is well beyond the scope of this thesis, although the classical Irish poetic metres' relationship with stress/accent/PLP – or rather, their lack thereof – are returned briefly to in discussion of Irish suprasegmental phonology in Chapter 3. However, it was the above-introduced vague but longstanding traditional notion of stress/accent (variably as equivalent terms, as non-pitch versus pitch-based prominence-marking, or as abstract versus realised prominence in either polarity) which was current when philologists, dialectologists, and linguists began undertaking formal and systematic study of the same in the 19th century, and continuing through the 20th to the present day. It is worth noting also that the two competing terms 'stress' and 'accent' are essentially translations of one another, one (stress) from Old English's original Anglo-Saxon lexicon, and one (accent) from French (van der Hulst 2014)[3]. The existence of such doublets is not uncommon in English, given the complex and multi-layered history of the language's development. In this particular case, however, it has left room for no shortage of ambiguity in the use of the two terms for theoretical purposes.

Thus, in keeping with the bottom-up, phonetic nature of the present work, I refer to 'prominence' at different levels of phonological structure, and in different phonetic domains. As noted above, for the remainder of the thesis, I use 'phonological lexical prominence' (PLP) to refer to what has been variably known as both 'stress' and 'accent' in previous works: the abstract property marking one syllable of a word as stronger than others. PLP is 'phonological' in the sense of being a formal structural characteristic (in this case of a syllable), and 'lexical' in the sense of specifically – and obligatorily – applying at the level of the word. PLP has the potential to be lexically contrastive, as in, e.g., Dutch, but also may simply define the prosodic shape of words in a given language. While non-contrastive, the latter may affect synchronic derivational morphology or diachronic change (as in the shortening of non-PLP long vowels in the transition from Primitive to Old Irish; McCone 1994).

This approach is consistent with van der Hulst's (2014) suggestion to move towards more neutral terminology with reference to lexical prominence by focussing on the relationship between "formal *marks* on syllables…and *exponents or correlates of these marks*". This, of course, is what most if

[3]The French *accent* is from Latin *accentus*, itself a conceptual calque of the Greek προσοδία (Allen 1973: 86).

not all work in this domain aims to do, typically by outlining an author-specific definition of traditional terms and/or compounds derived from them; the slightly cumbersome nature of changing traditional terminology seems a small price to pay for greater clarity within and across works. By and large, I will avoid the term 'stress' unless it is necessary for reference to the work of others (e.g. 20th-century dialectological descriptions of lexical prominence). Similarly, I restrict the use of the term 'accent' to use within discussion of 'pitch accents', used in the Autosegmental-Metrical sense of a phrase-level, phonologically specified pitch contour outlined in Section 2.4 below.

2.1.2 Typology of lexical prominence

Lexical prominence is contrastive in many languages, and, independently, may have its location determined by rules of varying degrees of complexity and with varying permissiveness of exception. The claim that phonological lexical prominence, of one type or another, is *universal* is not uncommon historically, but is increasingly considered to be controversial (Hyman 2014). This controversy derives from the terminological ambiguity discussed above, the nature and reliability of the data for a given language or languages, and disproportionate representation of a relatively small number of Indo-European languages in foundational literature on the topic.

Hyman (2014) outlines three distinct families of approach to lexical prominence, for which his own usage differentiates between 'word accent' ("…the phonological marking of one most prominent position in a word…") and '(word) stress' ("…a common type of prominence marking…"). The first of these is phonetic: approaches concerned with the physical realisation and perceptibility of lexical prominence. The second is functional: approaches concerned with the "communicative motivations" of lexical prominence, e.g. its utility for demarcation of word and/or phrase boundaries. The third is formal: approaches "…interested in stress in terms of its organisational or structural properties." Additionally, there are competing claims concerning both the basic *function* of lexical prominence and the parameters restricting its crosslinguistic variability. The Prague School of linguistics, associated in particular with Roman Jakobson (e.g. Jakobson 1931) and Nikolai Trubetzkoy (e.g. Trubetzkoy 1939) and heavily influential in the development of what later became 'generative' linguistics in the mid-20th century, took lexical prominence to be fundamentally demarcative – i.e., its function is to signpost the number of words that an utterance contains, and the location of the breaks between them. To this point, the ideal so-called 'canonical stress' was postulated to be (adapted from Hyman 2014):

a. Obligatory – required for all words
b. Culminative – unable to be duplicated within a word
c. Predictable – rule-determined in its location
d. Autonomous – reliant solely on phonology
e. Demarcative – calculated with reference to a word edge
f. Edge-adjacent – ideally initial or final
g. Non-moraic – independent of syllable weight
h. Privative – there should be no secondary ‘stress’
i. Audible – signalled by phonetic cues

If the above set the terms for an idealised, prototypical system of lexical prominence (highly regular, highly predictable, purely positional, and purely demarcative), it is clear that the vast majority of languages fall short of the mark; exceptions to nearly all of the above canons exist in abundance. The most viable of the above desiderata are obligatoriness (although this has come increasingly into question, cf. van Zanten, Goedemans & Pacilly 2003 and Goedemans & van Zanten 2014 on Indonesian, and general discussion of universality of lexical-level prominence in Hyman 2014), and audibility. These border on trivial: if a language distinguishes syllable prominence within words, then it seems uncontroversial that all words will have a most prominent syllable, and that that prominence will be identifiable. The exact nature of the latter audibility/perceptual salience, however, is *not* trivial.

PLP may be signalled by (i) intensity (i.e. loudness), (ii) pitch, (iii) segmental quality, and/or (iv) duration; a given language may use only one of these features, all of them in concert, or a subset thereof. Further, each of the features may apply (i) positively to prominent syllables, (ii) negatively to non-prominent syllables (i.e. reduction), or (iii) both positively and negatively. These phonetic exponents can additionally be used at a phrasal level to signal, e.g., phrase structure and/or focus, which may or may not be structurally tied to lexical-level syllable prominence. A great deal of research has investigated the phonetic correlates of PLP – generally in search of a consistent analogue of the proposed perception of ‘increased effort’ – with heavy focus on Germanic languages (particularly English, German, and Dutch), often with conflicting results (Cutler 2011; Cutler & Jesse 2021). The results of early perceptual studies of English (Fry 1955, 1958, 1965; Mol & Uhlenbeck 1956; Bolinger 1958; Lieberman 1960) found pronounced F0 activity on a syllable to most reliably cue the perception of PLP, with negligible impact of, e.g., intensity. However, this has not been borne out cross-linguistically, and even with English appears to be at risk of confound with factors such as vowel quality and duration, as well as analogical use of lexical knowledge (Cutler 2011; Cutler & Jesse 2021).

As for the remaining ‘canonical’ features, divergences from the ideal PLP system outlined by the Prague School abound. Against strict predictability, languages like Russian and English may have loose preferences for default assignment, but highly mobile PLP location can in principle be lexically contrastive (Hyman 2014). With that said, even for such languages, cases in which PLP location is the sole bearer of lexical contrast are rare (Cutler 2021). PLP in languages such as English and Irish are often described as exhibiting sensitivity to which ‘strand’ of the lexicon a word belongs (e.g. differential Latinate and Germanic prominence assignment in English) and to morphological structure (e.g. apparently ‘unstressable’ affixes in Irish). PLP is demonstrably not universally restricted to initial or final position: weight-based stress systems have received a great deal of attention in the phonological literature, and secondary stress is well-documented in a number of languages, including in English. Of course, the existence of these counterexamples is not necessarily damaging to the notion of a canonical ideal; it has been argued that attested lexical prominence systems represent divergences from historically demarcative systems (Hyman, 1977; Bybee *et al*. 1998). Hyman (2006) offers another, more limited, set of parameters for PLP (‘stress-accent’): in languages exhibiting apparent PLP, lexical prominence will be obligatorily restricted to the syllable as its unit of reference and implementation, and all words will contain one and only one syllable specified for the highest level of prominence.

To this, it is worth adding that whether it is positionally fixed, predictable on the basis of syllable count/content, or lexically idiosyncratic, discussion of PLP in generative linguistics (including rule-based phonology and Optimality Theory) is broadly bound up with the concept of *productivity*. Accounts of phonological phenomena in these frameworks broadly assume that their object of study has been actively generated – that is, produced – by a speaker’s phonological system. The aim is then to capture the circumstances under which such a ‘productive’ process will apply, and how variation in the results can be explained. Thus, authors discuss PLP ‘assignment’ in language varieties under analysis, or ‘selection’ of optimal PLP patterns; these theoretical frameworks posit rules or constraints to ‘generate’ the linguistic output observable as data (see discussion in Odden 2011). The extent to which these accounts describe psychologically real processes that literally occur in real time (that is, reflect active, on-line derivation by language users), or rather more abstractly describe a diachronic accumulation of factors which can explain synchronically attested forms, is a vast and varied debate (Hansson 2011; Goldrick 2011).

In contrast, other, non-generative (‘functional’ or ‘usage-based’) approaches have less trouble attributing observed patterns to stochastic properties of lexical frequency, language-user experience of ambient data, and broad productive and perceptual constraints not exclusive to a language or phonological module (e.g. Bybee *et al*. 1998, for whom “stress…is considered an inherent part of the word”). The relationship between rule- or constraint-based treatments of PLP systems and psychological reality with respect to synchronic language users comes to the fore particularly when considering lexical 'exceptions' to the rules or constraints proposed (Probert 2004: 311-312). This is noteworthy when considering the treatment of PLP in Munster Irish and beyond; generative accounts of PLP claim on some level to describe a process or suite of processes (whether negatively selective constraint-based, or positively creative rule-based) that actively overlay(s) prominence onto phonological words that do not have an exceptional by-item lexical specification. It is precisely the issue of productivity of Munster Irish syllable weight and PLP location-assignment that the nonword production task described in Chapter 6 is concerned with, addressing RQ2c.

Up to this point, the discussion of PLP has referred to the feature as described by linguists. Implicit in this is the assumption that linguists' perceptions and descriptions are essentially objective. The substantial flaws in this assumption are of particular relevance to the present work on prosody in Munster Irish. Traditionally, the description and analytical interpretation of data on PLP has been "theory-dependent and highly personal" (Hyman 2014). This is directly connected to the pervasiveness of an inherited, amorphous notion of 'stress/accent' as a unitary productive and perceptual phenomenon not only universally found in human language, but also universally understood within a relatively small margin of variation by the scholars, analysts, and theoreticians who use the term(s). However, prominence marking is language-specific; different languages or language varieties may implement information at the lexical and/or phrasal levels in a variety of ways, and may or may not allow the two to be conflated or synchronised. The decomposition of PLP, its assignment and rigidity thereof, its production/implementation, and its perception, are crucial to a phonetic approach to prominence and related phenomena from first principles.

The practical role of PLP is of particular importance. This has been examined by, amongst others, Vogel, Athanasopoulou, and Pincus (2016) with respect to phonetic prominences and the *Functional Load Hypothesis* (FLH), which in its original form (Martinet 1955) framed diachronic phonological and morphological change in terms of the functional weight borne by particular features undergoing change. Using experimental data from speakers of Greek, Hungarian, Turkish, and Spanish, Vogel *et al*. (2016) investigated the relationship between (i) contrastive and non-contrastive lexical prominence, (ii) lexical and sentence/phrase-level prominence, and (iii) predictability of prominence location and consistency of its implementation. Their approach emphasises the potential ambiguity between different exponents of prominence (e.g. duration, intensity, change in pitch), which may arise from systematic coordination or incidental contextual overlap. Their results support a crosslinguistic dispreference to co-opt a phonemically contrastive feature for supraphonemic prominence, whether independently contrastive or non-contrastive. Hungarian's phonemic vowel length, for example, appears to disqualify the use of duration as an exponent of prominence at the lexical or phrasal levels. Similarly, Cutler (2011) brings together perceptual evidence from previous studies of Thai (Potisuk, Gandour & Harper 1996), Mandarin (Shen 1993), and the Mayan languages K'ekchi and Cakchiquel (Berinstein 1979) to emphasise that listeners attune to different acoustic cues in attempts to identify PLP based on the distribution of segmental phonological features in their L1.

Furthermore, Vogel *et al*.'s (2016) data from Greek and Spanish support the possible division of labour in marking lexical vs phrasal prominence, with F0 activity and syllable intensity playing different roles in each language. Less straightforward results were obtained for Turkish, the only non-Indo-European language under consideration, and one in which PLP is non-contrastive and largely restricted to final position by default – pitch change was most strongly associated with the PLP-bearing final syllable, while intensity was consistently higher in the syllable preceding PLP. Whole-word intensity increases were observed under phrasal focus conditions. This could be consistent with a language which does not "care" a lot about PLP, to follow Hyman (2014), exhibiting relatively consistent prosodic features facilitate identification of word boundaries, but have little interaction with other phonological processes. By contrast, a language such as English has very robust PLP, which is lexically contrastive and referenced by multiple phonological and morphological processes. This yields a complex web of suprasegmental parameters such as intensity and pitch, quantity- and quality-reductions in non-prominent syllables (e.g. unstressed vowel reduction), and specific etymological and morphological factors.

The functional-structural angle on prominence explored by Vogel *et al*. (2016), amongst others, is of particular interest for the study of a language such as Irish, which due to its highly minoritised status in comparison to English may suffer considerably in analysis when implicitly treated as equivalent to the latter. In particular, the functional role of PLP itself, as well as the functional role of the various potential phonetic exponents of PLP should not be assumed *prima facie* to match those of English – although this is not to say that close investigation is precluded from finding this incidentally to be the case. These factors must be considered dynamic in light of dramatic sociolinguistic change in Irish-speaking communities over the last two centuries, which now have virtually universal bilingualism with English. Indeed, as noted above, the FLH was formulated with regard to language change. Shifting functional loads in the face of, e.g., now (near-)universal bilingualism with English, and growing English dominance amongst said bilinguals, could conceivably play an important role in the phonological and phonetic character of prominence in the language. It has been suggested that prosodic features, including PLP, may be more susceptible to contact-induced change than segmental phonological features on the back of evidence for hybrid PLP-assignment systems and intonational features in minoritised Amerindian languages (Rice 2014).

The possibility of such influence – especially in the context of minoritisation in addition to prolonged, multigenerational bilingualism – and its timescale, are important to bear in mind as the Irish context is considered. It is not necessarily safe to assume that modern speakers of a language are fully representative of previous stages of a language, especially when dealing with such an opaquely and impressionistically recorded feature as PLP. The earliest descriptions of Irish lexical prominence are purely impressionistic, and predate the earliest acoustic data by over a century. Yet it is common to accept such arguably pre-phonological descriptions of (P)LP as (i) accurate with respect to contemporary speakers' productive PLP systems, and (ii) directly compatible with data collected from present-day speakers. In comparing data collected over a century apart, as in Chapters 5 (lexical prominence) and 7 (intonation), it becomes clear that substantial changes have occurred in Munster Irish over the past century at both a lexical and phrasal level, and that such assumptions are not well-founded. This is by no means restricted to the Irish context, and is a current issue in the cross-linguistic literature on lexical prominence (de Lacy 2014).

Cross-linguistic variability in direct PLP signalling, phrasal prosodic effects, and phonotactics (i.e. specifications for licit sound combinations) has been approached in a more zoomed-out, phonetic manner using so-called *rhythm metrics*, which seek to quantify productive rhythmic properties in a given language, such as relative duration of syllabic or phrasal constituents, although not without controversy. Although rhythm metrics are not used in the present work, they have previously been applied to the study of Irish varieties (Dorn 2014; McCabe 2018), and their underlying motives and intuitions intertwine with approaches to lexical and phrasal prominence.

Quantitative work on speech rhythm arose from previous attempts to classify languages according to their enforcement of isochrony (equal duration) at one or more levels, of which Pike's (1945) proposed dichotomy between *syllable*- and *stress-timed* languages is perhaps the best known. This proposal would divide languages into those which exhibit roughly equal syllable durations, regardless of PLP or phrasal prominence considerations, and those which space PLP-bearing syllables at roughly equal intervals, with non-prominent syllables durationally compressed to fit into these stretches. The inter-PLP interval is what Abercrombie (1967) termed the 'stress-foot', a ubiquitous term in the study of speech rhythm and linguistic metre.

Instrumental empirical investigation of languages' durational properties over the course of the 20th century, however, failed to find evidence in favour of this strict divide (Nespor 1990; Nolan & Asu 2009). From the late 1990s, a new, more phonetically-rooted approach to the measurement and classification of speech rhythm was developed, of which the pairwise variability index (PVI; Low 1998; Grabe & Low 2002) and the %V/%C/ΔV/ΔC suite (Ramus, Nespor & Mehler 1999) are best known. The former entails calculating the average of pairwise differences in a given measure (most often duration, but potentially any prominence measure) for a selected speech unit (segments, syllables, feet, etc.) over the course of an utterance, and can be optionally normalised for speech rate. The latter quantifies the percentages of an utterance comprising vocalic and consonantal/intervocalic segmental material, and the standard deviations of such intervals. As measurements of phonetic data, these and similar related metrics are not mutually exclusive in application.

The above rhythm metrics have been applied to the systematic study of prosodic/metrical organisation of various languages. Grabe and Low (2002), for instance, carried out PVI measurements for samples of 18 languages from a variety of language families; results showed gradient differentiation of languages, with apparently polar separation of perceptually rhythmically distinct languages such as Spanish and Mandarin (classic examples of ‘syllable-timing’) and English, German, and Dutch (classic Germanic examples of ‘stress-timing’). However, the extent to which these measurements are meaningful for generalisation beyond their immediate experimental (and speaker/utterance-sample) contexts has been sharply criticised by scholars such as Arvaniti (2009). In a study comparing data from Catalan, Spanish, and English, Prieto and colleagues (2012) investigate the effect of language per se versus syllable structure(s) in the experiment-specific speech materials on the outcome of both PVI and Ramus-suite rhythm metrics. Their findings lend modest support to language-differentiation, which the authors attribute to language-specific strategies for marking prominence at both lexical and phrasal levels. Of general relevance for the present work are the consequences of phonological metrical structure and its phonetic implementation for the perception of complex characteristics such as ‘rhythmic character’. The issue of perceptual rhythm itself is returned to in the following section.

To circle back from the broader consideration of rhythm production, much phonological and phonetic work on PLP relies on stipulated location of the same. That is, researchers examining the government of PLP location, its contrastivity, or its phonetic correlate(s) in a given variety typically begin with knowledge of PLP location in individual lexical items. This is not necessarily problematic, particularly in languages with large speaker bases including monolinguals, in which speakers exhibit strong intuitions about relative syllable prominence. However, while such a stipulation may work well for Germanic and Romance languages, it is not universally reliable. As noted above, the study of PLP in many language varieties – often under-studied and/or minoritised – typically relies on descriptions of PLP sourced from grammars, which may rely on insufficient samples, or anecdotal authorial claims, and which are generally unaccompanied by recordings.

Descriptions of this type for PLP may be written by authors who are not L1 speakers of the language in question. For example, many grammars of Amerindian, African, and South Asian languages were written by missionaries. Additionally, for 'all-in-one' grammars, PLP furnishes a rather minor topic in comparison to morphosyntax and segmental phonology. When this is considered in combination with a vague, inherited notion of PLP as a universally attested phenomenon with uncontroversial implementation and perception, it becomes clear that the reliability of such descriptions cannot be taken at face value. This is explored in some detail by de Lacy (2014), who interrogates theoretical claims made on the basis of vague descriptions of Mapudungun PLP, concluding with his "fear…that significant generalizations about [phonology] have been missed and theoretical development has been derailed because inadequate, irrelevant descriptions have been assumed to be valid evidence."

The relationship between prominence at different levels, and cross-level coordination or lack thereof, has been explored by Gordon (2014), who proposes a distinction between 'bottom-up' and 'top-down' languages with respect to the implementation of pitch-accent (defined in his usage as "tonal prominence distinct from tones associated with the boundaries of intonational constituents"). In bottom-up languages, lexically non-contrastive pitch prominence at the phrasal level is something to which a given PLP-bearing syllable is promoted; levels of prominence are built from the ground up, with a harmonised relationship across the levels as syllables are optionally promoted further up in the hierarchy (e.g. from abstractly PLP-marked to overtly focus-marked with salient pitch movement unrelated to lexical contrast). In top-down languages, however, "pitch accents are not necessarily projected from word-level stress [PLP] but rather may be assigned based on at least partially orthogonal principles".

The latter orthogonal principles are typically positional, such as a particular pitch movement being consistently associated with the final phonological word in an intonational phrase. Indonesian, for example, has historically been described as exhibiting penultimate PLP. However, this has been demonstrated to be more accurately accounted for as a phrase-final pitch movement independent of considerations at the lexical level; lexical prominence is apparently completely non-contrastive, and manipulation of syllables for typical phonetic prominence exponents (e.g. increased intensity or duration) offers no benefit in lexical identification or felicitousness to Indonesian listeners (van Zanten & van Heuven 1998). More recently, it has been suggested that Munster Irish represents a top-down prosodic system, based on statistical analysis of the relationship between phonetic prominences, PLP and phrasal focus (Windsor, Coward & Flynn 2018). The details of Windsor *et al*.'s investigation are returned to in Chapter 3's discussion of PLP in Irish.

Related to the above is the phenomenon of so-called *stress deafness* (Dupoux *et al.* 1997; Dupoux, Peperkamp & Sebastián-Gallés 2001; Dupoux & Peperkamp 2002; Peperkamp & Dupoux 2002), in which native speakers and non-native or non-speakers diverge in their perception of PLP. This may pertain to the perception of PLP at all, i.e. whether or not it can be identified in a given stimulus. Alternatively, it may pertain to the perception of PLP location. The former ‘total’ deafness is evident in cases such as that of Indonesian, discussed above; non-native speakers of Indonesian, including academic linguists, perceive PLP where native Indonesian speakers show no sensitivity to relative syllable prominence(s), even when this is introduced artificially in experimentation. Similarly, L1 French speakers have difficulty reliably identifying PLP in, e.g., nonwords, suggested to derive from the relative unimportance of syllabic prominence in French lexical contrast. This effect does not obtain for speakers of languages with robust PLP, such as Spanish (Dupoux, Peperkamp & Sebastián-Gallés 2001).

‘Locative’ stress-deafness, on the other hand, has been discussed with reference to, amongst other cases, Welsh (Jones 1949; Oftedal 1969; Williams 1983, 1985, 1986; Cooper 2015). Results from perception experiments comparing L1 Welsh and English speakers have suggested that native speakers reliably perceive PLP on the penult – consistent with formal descriptions of Welsh metrical phonology – whereas naïve English listeners perceive PLP on the following syllable, which is often characterised by a notable pitch ‘bounce’. This was originally taken to evidence a systematic prosodic phenomenon, unintuitive to L1 English listeners: salient phonetic prominences occurring one syllable after PLP. More recent analysis of intonation by Cooper (2015) using laboratory data, however, suggests that high pitch prominence can be seen to align with the PLP-bearing syllable if context is controlled for. This does not diminish the relevance of the perceptual phenomenon in question, namely the non-native misperception of PLP, but it does exemplify the risks of attributing a typologically unusual feature to a given language variety in the absence of sufficient data.

To summarise, phonological lexical prominence – a more explicit nomenclature replacing the traditional terms ‘stress’ and ‘accent’ for the purposes of the present thesis with respect to van der Hulst’s ‘formal marks’ of syllabic prominence – is a complicated matter. The study of PLP has been marked by both oversimplicity (the generic assumption of a universally relevant and understood type of syllable prominence) and overcomplexity (highly theory-specific definitions of traditional terms; misattribution of PLP-related characteristics or PLP writ large to languages on the basis of insufficient or inappropriate data). It is possible in principle, though at times difficult in practice, to distinguish between PLP and various phonetic prominences. Some or all of the latter, such as duration, intensity, spectral tilt, vowel quality, and pitch, may relate to PLP-marking in a given language variety, but others may relate to other layers of prominence, such as phrasal focus. Languages may further differ in how they relate such layers of prominence to one another. PLP may be more or less central to the phonology and morphology of a given language, and this must be borne in mind during evaluation of data. Furthermore, the perception of PLP can be heavily influenced by a listener's L1 and metalinguistic knowledge. All of this is directly relevant to the present study of prosody in Munster Irish. As returned to in Chapter 3, this relates in particular to theoretical accounts of PLP based on anecdotal non-L1 dialectological descriptions, and questionable functional load borne by PLP in Irish.

2.2 P-centres and perceptual rhythm

Related to the perception of syllable prominence, and indeed of syllables generally, is the concept of the so-called *perceptual centre* or *P-centre*, which has been of interest to researchers in psychology, psycholinguistics, musicology, and phonetics since its identification in 1976 by Morton, Marcus, and Frankish based on evidence from listeners' perception of apparent regularity in speech rhythm. The sketch of P-centres provided below is important for the framing and justification of the perceptual rhythm experiment undertaken in Chapter 4.

The term *P-centre* refers to the point at which a listener perceives that a syllable is occurring, the acoustic identification of which is not as straightforward as may be presumed. Morton and colleagues identified this phenomenon when, as part of a psychological experiment in which listeners were exposed to isochronous sequences of digits (i.e. 'one…two…three…'), it became clear that stimuli evenly spaced with respect to the acoustic onset of each respective syllable did not yield a rhythmic percept. The 'rhythmic' sequences which the authors had generated as a matter of course for their experiment consisted of identical intervals between the onset of acoustic energy for each digit, e.g. the initial [w] of 'one', the release of [t] for 'two', the beginning of frication for the [θ] of 'three', etc. Participants reported that the timing of these stimuli was distinctly arhythmic. To pursue this further, the authors asked participants to adjust the relative spacing of the syllables in question until the sequence *did* generate an even, rhythmic percept. The result was not evenly spaced with reference to any obvious acoustic feature or landmark (Morton *et al.*. 1976; Marcus 1981). 'P[erceptual]-centres' were then defined as the points which needed to be evenly spaced in order for a sequence of stimuli to sound isochronously timed. These points were hypothesised to be the point at which a listener perceives that a new stimulus is being produced – the "psychological moment of occurrence" (Morton *et al.*. 1976). The inequivalence between straightforward, acoustically constructed isochrony and the type of perceptual rhythmicity satisfactory to listeners based on the proposed P-centres is illustrated in Figure 1.

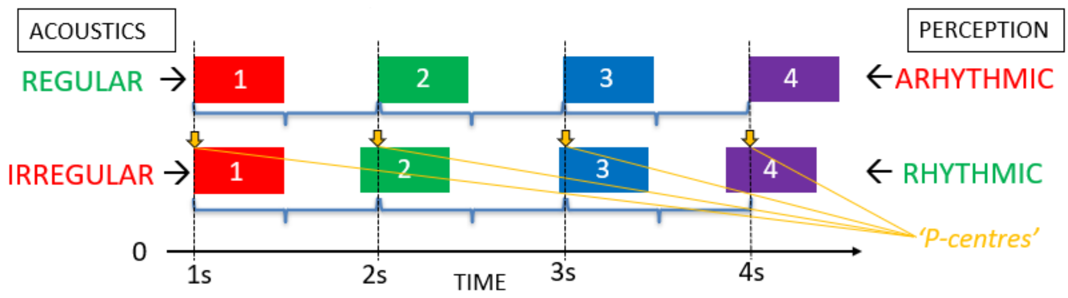

Figure 1 *Conceptual illustration of alignment of acoustic onsets (top) and P-centres (bottom)*

Since that time, there has been considerable work dedicated to trying to identify acoustic correlate(s) for the P-centre, with limited success. Rejected candidates include: the acoustic onset (the original, default assumption undermined by Morton *et al.*'s findings), local or global intensity peaks, and the vowel onset (i.e. beginning of the syllable rhyme). The current frontrunner is the midpoint of the rise in amplitude at the beginning of a syllable (Villing *et al.*. 2011). Related to the exact acoustic correlate of the P-centre are (i) its means of estimation, and (ii) factors apparent in its relative location. These two elements are discussed below.

Perhaps the most important feature proposed to characterise the P-centre is *context insensitivity*. That is, P-centre location is apparently unaffected by surrounding acoustic context. This was noted from the earliest proposal of the P-centre, at which point the question was left open as to whether "they [P-centres] are subject to phonological, semantic, or syntactic influences in situations more closely approximating continuous speech" (Morton *et al.* 1976). Subsequent work on variation in P-centre location has continued to support context insensitivity (Villing *et al.* 2011), with no evidence of systematic variation in P-centre location in the face of controlled variation in adjacent acoustic context (and this alone, i.e. without covariance of one or more other parameters). Context insensitivity underpins multiple methods for determining P-centre location (Villing *et al.* 2011).

Villing, Repp, Ward, and Timoney (2011) provide a useful overview of the numerous methods that have been used to estimate P-centre location before going on to propose a new one of their own (the *Phase Correction Response*; PCR). The first produces the *absolute P-centre*, and relies on a common point of reference (e.g. a continuous acoustic stimulus, such as a metronome beat). The second is the *rhythm adjustment method* (RAM), in which listeners are presented with an alternation between two stimuli, a 'base' and a 'test'. Listeners are then tasked with adjusting the location of the test stimulus within a cycle until the *point of subjective isochrony* (i.e. the perceptual rhythmicity). From there, event-local P-centres can be solved for mathematically, or one reference sound can be used to measure relative delta P-centres for the stimuli in question. The authors' own proposed method, the PCR, relies on participants tapping along to a sequence of evenly timed stimuli (e.g. a metronome beat), and measures the degree of their compensation when a stimulus beat is unexpectedly produced out of time. A simple and easily-implemented approach to P-centre estimation is metronome synchronisation: participants are directed to repeat simple stimuli in time with a metronome beat, and the point at which a given target aligns with the metronome beat is stipulated to represent the P-centre. The 'objective' absolute P-centre may be several milliseconds before or after the metronome beat, but, given the assumption that a participant's anticipation or delay will be consistent, this still allows for generalisations about relative P-centre location (Fox & Lehiste 1987). This method has been used in a number of linguistic studies, such as Fowler and Tassinary (1981), Barbosa *et al.* (2005), Franich (2017, 2018) and Šturm and Volín (2016).

When carrying out experiments involving metronome synchrony, researchers often make note of participant musicality or lack thereof. This is reasonable to consider in light of the potential for common processing of linguistic and non-linguistic prosodic features, especially for rhythm (Franich 2017: 169; Franich & Sarkar 2019). Musical training of various degrees has been demonstrated to have an effect on individuals' ease of entrainment to rhythmic patterns (Nozaradan *et al.* 2016; Stupacher *et al.* 2017). Similarly, following and/or producing complex rhythmic patterns has been shown to activate areas of the brain typically associated with language use and processing (Vuust *et al.* 2006). Evidence suggests that the consequence of participant musicality is more to do with ease of entrainment and consistency of pattern maintenance than with the overall results of said entrainment. That is, pattern clarity may vary between musicians and non-musicians, but the pattern overall is expected to show only minimal effects of musicality.

Measurement of the location of this psychoacoustic perceptual landmark dovetails with theorising about its relevance for phonological prosodic structure, particularly within oscillator-based frameworks such as Articulatory Phonology (Browman & Goldstein 1992) and Port *et al.*'s (1995) 'temporal phonology'. Emergent phonological accounts of speech rhythm in this vein typically make reference to a series of nested oscillators roughly corresponding to levels of the traditional prosodic hierarchy (i.e. syllable<foot<prosodic word<phrase). Working from the assumption that the peaks of each of these oscillation cycles form a point of rhythmic reference for the language user, researchers can make use of *speech cycling* tasks in order to investigate the behaviour of different levels of the rhythmic hierarchy (Cummins 1997a). Similar to the above-described metronome synchronisation tasks used for P-centre estimation, speech cycling tasks involve the coordination of phrases or sentences with one or more metronome beats. When beats of multiple speed are included, rhythmic peaks at different levels are expected to roughly align with higher- and lower-order points in the metronome repetition cycle(s). In the context of speech cycling experiments, P-centres have been described as the attractors of phasic prominence targeted by

participants (Barbosa *at al.* 2005). The potential overlap between microscopic P-centre study and productive features of higher-level prosody are of particular interest for the present work, which combines the study of P-centres with a broader focus on prosodic prominence at the lexical and phrasal levels.

As noted above, P-centre location is taken to be insensitive to surrounding phonological context; the number of preceding syllables, for example, will not affect the location of a given syllable's own P-centre. However, beyond this there remains the possibility of other parameters affecting P-centre location, something which has been of interest since the early stages of the P-centre enterprise in the 1970s. Being essentially an onset phenomenon (or, at the very least, a left-periphery phenomenon), researchers have investigated, amongst other factors, the effect of onset duration on P-centre stability. Findings suggest that increased onset duration yields leftward shift of P-centre location, and that this effect is more robust than rightward movement in the face of increased syllable rhyme duration (Marcus 1981; Cooper *et al.* 1986).

Related to this are effects of onset complexity. In a metronome synchronisation task, Fowler and Tassinary (1981) describe that their participants aligned metronome beats increasingly early relative to the vowel onset of monosyllabic targets as onsets increased in complexity (e.g. from an 'onsetless' vowel-initial syllable, to a single stop onset, to an initial consonant cluster). In an early brush with morphological complexity, Fox and Lehiste (1987) investigated the effects of affixation on P-centre location. They observed a weak trend of rightward movement following the addition of (unstressed) suffixes to monosyllabic English words, and a much more robust trend of leftward movement in the presence of prefix(es). One of their conclusions was that the behaviour of 'speech rhythm', especially perceptual, cannot be predicted or described solely on the basis of acoustic properties of phonologically prominent syllables. A more recent study of disyllabic words in Czech, also in a metronome synchronisation paradigm, provides further support for an effect of phonological complexity on P-centre location (Šturm & Volín 2016). Šturm and Volín observe that P-centres in their data occur earlier in more complex syllable structures, noting once again an asymmetrically strong effect of onset complexity over rhyme composition.

Pertinent to the study of word-initial syllable onsets in Irish, which are subject to frequent alteration under the two morphophonological processes of initial mutation, is Franich's (2017; 2018) work on P-centres in Medʉmba, a Grassfields Bantu language spoken in Cameroon. Medʉmba exhibits morphophonologically conditioned prenasalisation of word-initial consonants in addition to underived prenasalised consonants. This is not dissimilar to the historical stage preceding the development of morphosyntactic, phonologically unconditioned, initial mutation in the Celtic languages (McCone 1994; Fife 2009; Stifter 2009; Ó Baoill 2009). Franich's Medʉmba study investigated whether segmentally identical prenasalised words distinguished by their morphological status (i.e. whether their initial prenasalisation was contextually derived or lexically underlying) exhibited distinct rhythmic properties.

By means of a metronome synchronisation task, P-centre data were collected on plain and prenasalised lexical targets, with the latter including both derived and underived cases. Strikingly, insofar as the results were robust, this returned statistical evidence of differential rhythmic treatment of targets on the basis of morphophonology. Derived and underived cases of the same segmental strings exhibited different P-centre locations. In non-derived cases of prenasalisation, participants placed metronome beats closer to the onset of the vowel, consistent with their treatment of non-prenasalised CV targets. In derived cases, however, metronome beats, and therefore P-centres by convention, are located mid-onset, consistent with treatment of initial clusters. The treatment of segmentally identical instances of prenasalised initial consonants, differentiable only on the basis of morphological status raises questions about the possible role(s) of morphophonology in temporal organisation. This motivated investigation of the treatment of similar cases of near or total segmental homophony in Irish initial mutation (RQ1), as presented in Chapter 4.

To summarise this section, P-centres represent a point of overlap connecting speech perception and production. Fundamentally, they relate to our awareness of speech sounds as listeners. However, as a psychoacoustic rather than strictly acoustic phenomenon, they show evidence of being influenced by other elements of linguistic structure; this is noteworthy but perhaps unsurprising given the contextually integrated nature of speech perception. As evidenced by both production and perception experiments over the last five decades, the location of a syllable's P-centre is sensitive to properties of onset complexity and duration. Further, it may be the case that lexical morphology and derivation play a role in determining P-centre location. Variation in P-centre location has been suggested to explain subtle, cross-linguistically attested effects of onset structure on syllable- and lexical-level characteristics traditionally associated exclusively with the rhyme, including phonological lexical prominence (word 'stress'). This leads naturally into a discussion of a phonological topic central to the formal treatment of lexical prominence and the determination of its location in languages which permit multiple positional options: syllable *weight*.

2.3 Syllable weight

Having established basic definitional boundaries and related terminological issues surrounding phonological lexical prominence and having outlined relevant background on the perception of speech rhythm, I now turn to syllable weight. This is one of the most pertinent topics for determination of PLP location in languages without straightforward positional specifications, and one of particular relevance for the case of Munster Irish PLP as presented in the formal phonological literature and explored in greater depth in Chapter 3 below.

Languages may distinguish treatment of syllables on the basis of their relative substance, and these ‘weight’ distinctions can be used to determine the location of phonological lexical prominence (Gordon 2006: 1; Ryan 2019: 1). In such systems, syllables can be ‘heavy’ or ‘light’, although scales of more than two degrees are also attested (e.g. Hindi has a third ‘superheavy’ weight-class). The particular criteria for weight-reckoning vary widely cross-linguistically, as indeed do the contexts in which weight plays a role; Gordon (2006: 1) describes weight as “…that property which differentiates syllables with respect to their prosodic behaviour…”, noting in particular the difficulty of a more precise definition given the range of phenomena associated with said property. In addition to playing a role in determining PLP location, weight has been suggested to play a direct or indirect role in the behaviour of word-minimality requirements (Steriade 1991; Gordon 2006: 211, 223-224), pitch-accent assignment and alignment (Steriade 1991; Röttger *et al*. 2012), and lexical tone (Gordon 2006: 89-95). Historically, duration has been considered to be the most straightforward phonetic correlate of phonological weight (Goedemans & van Heuven 1995; Goedemans 1998: 18, 109-112), although this has been called into question by research suggesting that it is not so much syllable duration as overall syllable energy which best aligns with established weight hierarchies in certain languages (Gordon 2006: 153-159). It seems likely that the production and perception of weight in gradient phonetic and categorical phonological senses integrates information from both duration (i.e. overall domain size) and energy (i.e. perceptual salience of said domain).

The relationship between syllable weight and PLP is a topic of particular interest. Some 30-50% of the world’s languages are described as having weight-sensitive PLP systems (Gordon 2006; Goedemans & van der Hulst 2013; Ryan 2019: 23). Gordon (2006: 141) notes an intuitive bidirectional link between the two phenomena: phonetic exponents such as duration and overall energy (i.e. intensity) are seen cross-linguistically to be used to mark phonologically prominent syllables for their special prosodic status, but, conversely, heightened salience in these domains for non-PLP reasons (e.g. coincidental with syllable structure or segmental sonority) can equally be used to *determine* where PLP should be placed. Here, however, there is a potentially circular ambiguity. How can weight as a PLP-location determinant and PLP location as a diagnostic of relative syllable weight be kept separate?

The case of Munster Irish comes to mind: a ternary and segment-sensitive formal weight system, treated in more detail in Chapter 3, has been suggested to account for impressionistically-described

PLP locations in grammars and dialectological studies, attracting attention for its apparent complexity "in the face of the pressure for structural simplicity" in the evolution of weight systems (Gordon 2006: 136). However, are such complex cases reliable in the first place if they rely on PLP location as their sole weight-diagnostic, and do not interrogate input PLP descriptions in the context of language-specific phonetic cues, structural/contrastive considerations, and lexical/etymological concerns? This is addressed for weight and productive PLP assignment in Munster Irish in the form of RQ2a-c over Chapters 5-6. In a more general sense, however, it seems worthwhile to highlight the risk of straying from weight's core utility as a way of grouping together syllable types based on their prosodic treatment; PLP location can of course contribute to that as a diagnostic, but this must be approached with rigour and scepticism.

In an overwhelming majority of cases, weight has been considered to be a property of the syllable rhyme, with onsets assumed to be ignored for the purposes of weight-reckoning (Ryan 2019: 24). There is limited evidence for overt inclusion of onset features in weight hierarchies, but such cases are very rare typologically (Gordon 2006: 189). In addition to inherited notions of weight-scanning inherited from classical poetics in Greek, Latin, and Sanskrit, support for a generally rhyme-centred notion of syllable weight has been drawn from, e.g., listener insensitivity to duration in onsets. However, although onsets play a far less robust role in weight-related processes such as PLP-assignment relative to that played by rhymes, there is evidence to suggest some degree of gradient participation. On the basis of a survey of PLP placement and classical poetic metres, Ryan (2014) presents statistical evidence that onset duration and complexity may be linked to weight-reckoning. On this basis, Ryan suggests that the weight-reckoning domain may begin with the P-centre, rather than with the onset of the nuclear vowel (and, by extension, of the syllable rhyme).

As outlined in Section 2.2, the P-centre, or a syllable's moment of 'perceptual occurrence' is associated with the left edge of a syllable; this is most commonly associated with the vowel onset, but moves earlier at least partially as a function of onset complexity. If Ryan's hypothesis holds true, this would link independently attested phenomena in psychoacoustic rhythm – namely evidence of leftward P-centre movement due to onset features such as featural makeup (e.g. voiced/voiceless), structural complexity (e.g. singleton/cluster), and morphology (e.g. derivational status of an onset) – and in more traditional PLP/metrical studies, such as cross-linguistic correlation between these same onset features and subtle weight effects.

For example, onset complexity in English has been demonstrated to strongly correlate with PLP assignment, even when other potentially covariant factors such as etymology, content/function status, and morphological complexity are controlled for (Kelly 2004). The close proximity between the P-centre and the beginning of the syllable rhyme would explain the general appearance of weight phenomena's ties to rhyme characteristics while allowing for slight effects of onset features as the P-centre undergoes segment-conditioned movement. This could also address Gordon's (2006: 189-190) concerns about voiceless onsets' greater weight-value than their voiced counterparts in rare cases of formally identified onset-sensitive weight systems, albeit with a phonetic account of weight more duration-heavy than energy-couched: earlier P-centres (exhibited particularly by voiceless, aspirated stops) would include more of the onset consonant in the weight-reckoning domain. The relationship between onset features, and either or both of phonological weight-reckoning and syllable-level duration, are of interest in considering the (in)stability of syllable composition in Irish (and in particular the onsets of initial syllables).

Theoretical accounts of the phonological structures underpinning syllable weight typically refer to abstract phonological units of representation, such as Hayes's (1985) *morae* - a term borrowed from poetics and imported to linguistics by Jakobson – which represent subsyllabic metrical units. A single mora (μ) is the minimum prosodic weight, yielding a light syllable, while the possession of two (or, in some languages, up to three) morae yields a heavy (or superheavy) syllable. Morae have been invoked to account for phonetic durational phenomena in a number of languages. Broselow, Chen and Huffman (1997), for example, discuss vowel duration across open- and closed syllables in Hindi, Malayalam, and Levantine Arabic, concluding that differences across these languages can be attributed to language-specific treatment of coda consonants with regards to mora-assignment, as schematised in Figure 2. In Broselow *et al.*'s data, sharing of a mora in Malayalam – which has a binary weight system – between a long (bimoraic) nuclear vowel and coda consonant led to vowel-shortening. Meanwhile, in Hindi – which permits superheavy/trimoraic syllables – this did not occur.

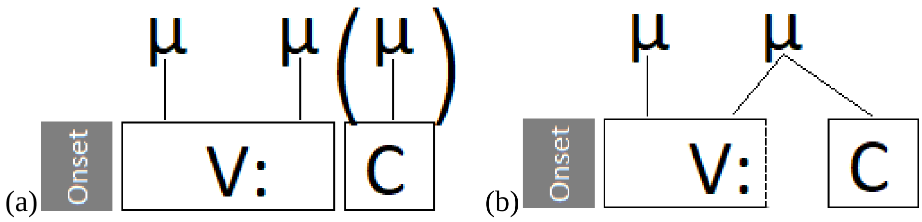

Figure 2 *Conceptual illustration of mora-structure for closed syllables in Hindi (a) and Malayalam (b)*

The above case of durational compensation for syllable- and/or weight-structure deals solely with the syllable rhyme. However, given suggestions of a relationship between onsets and rhyme-associated weight features tied to the P-centre, there is reason to consider similar compensatory phenomena on the left periphery of the syllable. Evidence of morphological derivation and segmental composition of onset consonants affecting P-centre location is notable in the context of Irish initial mutation (see Section 3.4.1). The interplay of P-centres, morphology, phonological weight, and phonetic duration relates directly to the exploration of vowel duration under phonological and morphological onset variation in Irish undertaken in Chapter 4, with particular relevance for RQ1.

2.4 Intonation

In addition to acting as a possible vector for lexical-level phonological prominence, pitch plays a robust role in signalling phrase structure, topical focus, and paralinguistic information such as speaker attitude. This phrase-level use of pitch falls under the broad umbrella of *intonation*. For the present thesis, the relationship between phrase-level intonation and lexical-level phonological prominence (whether signalled by pitch or not) is of particular interest, especially analytical conflation of pitch events associated across the two levels both cross-linguistically and in the Irish context. In this section, I provide a cursory sketch of phonetic and phonological approaches to the documentation, description, and analysis of intonation insofar as relevant to the current work. This entails the outlining of fundamental units of analysis for intonational study, frameworks for transcription and analysis, and theories about the phonological character of intonational units and their association with sub-phrasal lexical, syllabic, and segmental constituents. The historical context of intonational analysis is important for the treatment of RQ3 concerning Munster Irish intonation in Chapter 7, given the intertwined treatment of PLP and phrasal prosody which has formed the input for most formal phonological analyses of the variety's apparently complex PLP-assignment system.

2.4.1 Phonological representation of intonation

According to Nolan (2022), the study of intonation in the Anglosphere has received treatments as far back as the 16th century with John Hart's 1551 and 1569 discussions of orthographic punctuation and its spoken analogues, followed by Butler's 1633 exploration of 'tone', punctuation, sentence mode, and speaker attitude. These were succeeded by the somewhat more systematic, although still highly impressionistic and pre-phonological approach taken by Steele in 1775. The latter set about transcribing English intonation using pseudo-musical notation and distinguishes pitch events ('tone'), duration ('quantity'), pause, and strength ('emphasis' and 'force'). Three degrees of 'emphasis' couched in terms of weight ('heavy', 'light', 'lightest') are recognised, distinct from a continuum of force/loudness ranging from *piano* to *forte*. A broadly ternary hierarchy of 'stress' was also followed a century later by Sweet (1877; 1892), although there is no explicit definition of what makes a syllable 'stressed'.

Further development from the 19th into the 20th centuries developed into what has become known broadly as the 'British School' of intonation, rooted in auditory phonetic transcriptions of pitch (the majority of work in this School having taken place before the relatively recent wide and low-cost availability of graphic imaging of acoustic information). British School work was often explicitly developed for pedagogical purposes, as in one of the enterprise's standby reference texts *Intonation of Colloquial English* (O'Connor & Arnold 1973). Although – as noted with some emphasis by Nolan (2022) – this 'School' cannot be treated as a homogenous or monolithic approach to the topic of intonation, there are a number of shared core characteristics.

In the first place, British School analyses consider pitch contours to be the most basic meaningful unit for analysis, which can be strung together to create characteristic 'tunes' or 'melodies'. These contours are defined by their relationship to text at a syllabic (rather than, e.g., segmental) level, with 'stressed' syllables identified and marked in particular. Depending on the era and author, 'stress' was indicated either privatively and binarily or using some sort of gradient (e.g. the size of a dot/circle for a syllable associated with a transcribed pitch event). These syllable dots combine with (curvi)linear representations of perceived pitch movement to create the 'tadpole' diagrams now seen as characteristic of British School intonational work, illustrated in Figure 3.

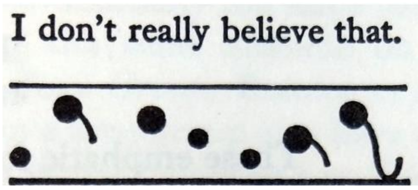

Figure 3 *Representative 'tadpole' diagram from O'Connor & Arnold (1973: 37)*

Also associated with the British School is the distinctive treatment of contours based on their position within a phrase. Beginning with Palmer (1922: 7), there was a distinction drawn between the *nucleus* (the PLP syllable of the most prominent word in an intonational phrase) and any material in the same phrase preceding it (the *pre-nucleus*). In later work (exemplified by Kingdon 1958), the pre-nucleus was further divided into a *head* and *pre-head*, and the nucleus was able to be followed by a *tail*. This led to the convention of equating the nucleus (or 'nuclear accent') and the final pitch accent in an intonational phrase, a practice adopted by post-British School analysts and retained in the present work. Chapter 7 distinguishes 'prenuclear' and 'nuclear' intonational events in its discussion of data from Munster Irish.

Contour-primitive approaches to intonation are restricted neither to the past nor to the British School – see, e.g., work in the so-called 'Dutch School' base in the Eindhoven Instituut voor Perceptie Onderzoek (IPO; 't Hart, Collier & Cohen 1990) or approaches based on Chinese tones

(Xu, Prom-on & Liu 2022). However, as the present work is concerned not with adjudicating between theories of intonation's phonological representation so much as with frameworks used to describe intonation in Irish, this sketch of the British School (the only contour-primitive approach used to describe Irish) will suffice.

A comprehensive survey of the myriad, overlapping systems of transcription and analysis associated with the British School is also rather beyond the scope of this thesis; far more thorough explorations of the topic can be found in Crystal (1969), Wells (2006), and Nolan (2022). What is of relevance for the task at hand is, first and foremost, the fact that work in this tradition was commonplace for dialectological treatment of Irish varieties in the 1920-1940s. Second, this work was exclusively auditory-impressionistic, albeit often by technological necessity and with a striking degree of accuracy. Finally, it does not provide a reliable distinction between abstract phonological prominence at a lexical level and transcribed percepts of intonational events; Kingdon (1958), for example, defines 'stress' as gradient "force employed in uttering a syllable". Other authors, such as O'Connor and Arnold (1961; 1973) take a broad view of 'stress' as lexical-level syllable prominence which can be combined with a pitch event to yield an 'accent'.

The British School of intonation is typically contrasted with one that treats not pitch contours, but rather discrete monotonal pitch *targets* as the basic unit of analysis. This has its origins in American Structuralism of the early- to mid-20th century (Pike 1945; Trager & Smith 1951; Liberman 1975). In its original incarnation(s), this levels approach provided for up to four levels, which specified relative pitch height of perceived phonological turning points in the intonation contour. Most pertinently for the present work, the early American 'levels' approach to intonation was largely superseded in the 1980s by what become known as the *Autosegmental-Metrical* (AM) framework, initiated by Pierrehumbert's 1980 PhD on American English intonation. This approach allows for only two broad 'levels' of pitch – H(igh) and L(ow) – which are arranged linearly on a distinct intonational tier of abstract phonological representation and aligned with 'stressed' syllables; the dynamic qualities of intonation are then understood to represent interpolation between these static pitch targets.

Pierrehumbert's approach and its offspring are 'autosegmental' in sharing with other autosegmental representations of phonology (stemming from Goldsmith 1976) a stratification of particular phonological features into their own distinct tiers, which are collapsed together at the point of phonetic production; they are 'metrical' in their emphasis on pre-intonational rhythmic structure. This approach to intonation was heavily influenced by contemporary work on African tonal languages (i.e. languages with contrastive phonological pitch-specifications at a lexical level), which attempted to tackle phenomena such as tone spreading and sandhi (contextual blending) using autosegmentality (Goldsmith 1976).

Unlike in British School analyses, left-headedness is not obligatory: right-headed pitch accents are equally possible (e.g. rising <L+H*>). The factors determining the attribution of a given head-directionality are to a certain extent author-specific, but are often couched in terms of semantic and contextual considerations in combination with relative strength (perceived or measured). Additionally, by virtue of using individual tonal targets as its basic unit, AM approaches are able to incorporate *boundary tones* into their analyses: edge-aligned targets in an intonational phrase which are independent of lexical or phrasal metrical structure. Such boundary tones are indicated with a <%>, e.g. a high final-boundary <H%>.

As a result of a series of workshops and collaborations in the 1990s, a broad and in principle cross-linguistically flexible transcription system combining existing AM practices with intuitions about the significance of pause characteristics (including duration) known as ToBI ('Tone and Break Indices') was developed (Silverman *et al*. 1992). Since that time, a number of language-specific ToBI adaptations have been created (e.g. GToBI for German; Grice *et al.* 1996). Related to ToBI, though distinct, is the IViE ('Intonational Variation in English'; Grabe, Nolan & Farrar 1999) system which combines British School approaches to English intonation (particularly obligatory left-headedness) with AM discrete levels, systemic bitonality, and boundary analyses (introducing a novel neutral boundary <0%>).

AM approaches to intonation typically attribute an inventory of single-target and bipartite 'pitch-accents' to a given language, in which the target associated with a metrically strong syllable is marked with an asterisk (e.g. a single <H*>, or a falling <H*+L>). Ideally, the identification of metrical 'strength' relies on non-intonational features such as intensity and duration, but there is precedent for the potentially circular use of pitch events themselves as markers of metrical strength. This is not unique to the AM framework, as seen in discussion of the often vague definition of 'stress' versus 'accent' in British School work above. The conflation of lexical and phrasal prominence is a particular bugbear in this area. While it seems straightforward to stipulate that only a lexically strong syllable (i.e. PLP-bearing) has the ability to associate with a non-boundary pitch event, language-specific characteristics of (i) PLP itself, including its existence and relative importance, (ii) directionality of intonation-implementation (Gordon's 'bottom-up' versus 'top-down'), (iii) inventory and relative frequency of pitch-accents, and (iv) temporal organisation of intonation have the potential to introduce ambiguity into the analytical process.

2.4.2 Timing and turning points

Research in the AM camp since the 1990s has also been associated with work on fine-grained temporal coordination between intonation and segmental structure, based on reported cross-linguistic evidence for the consistent alignment of salient turning points in the F0 signal – taken to be the phonetic analogues of AM pitch targets – with segmental landmarks in the speech signal. Arvaniti, Ladd, and Mennen (1998), for example, demonstrated that the L and H elements of the Modern Greek prenuclear rise exhibit consistent anchoring to the onset CV boundary of the PLP syllable and to the onset of a following non-PLP syllable, respectively. Regarding different phonetic/temporal implementations for pitch-accents of identical specification, in a series of acoustic experiments, Atterer and Ladd (2004) demonstrated the trough of rising L*+H in German to be consistently aligned later than that of the same pitch accent for English and Dutch. Whereas the latter exhibit L troughs slightly before the onset consonant of a stressed syllable, German Ls appear to be aligned either within the onset consonant (particularly visible in sonorants) or as late as the beginning of the PLP syllable's vowel.

Variability in tonal alignment has also been tied to (i) onset length and consonant sonority (Prieto, van Santen & Hirschberg 1995; Rietvald & Gussenhoven 1995), (ii) vowel duration (Schepman, Lickely & Ladd 2006), and (iii) increases in anacrusis (pre-tonic material) before prenuclear accents (Farrar & Nolan 1999; Dalton & Ní Chasaide 2007) and in post-tonic material after nuclear accents (Steele 1986; Silverman & Pierrehumbert 1990; Dalton & Ní Chasaide 2007). This phenomenon characterises alignment in a number of languages – including English and certain varieties of Irish – but is subject to substantial cross-linguistic variation. There is also limited but distinct evidence of contextual disambiguation by means of tonal alignment (Welby 2007; Post, d'Imperio & Gussenhoven 2007). In French, for example, Welby (2007) provides experimental evidence that the presence or absence of an F0 'elbow' cues native listeners to the presence of a content word's initial boundary. This was demonstrated using potentially ambiguous phrases such as *le ballon de mémentos* and *le ballon de mes manteaux* in a series of perception tasks involving word segmentation and identification of content versus function words. The facilitation of word segmentation and phrasal disambiguation by means of subtle F0 cues has been demonstrated, also in French, in cases of total segmental homophony (Spinelli *et al.* 2011).

There is debate as to whether anchoring and alignment phenomena pertain to the level of the segment, or rather to coordination within the syllable or a supersyllabic domain (e.g. the foot). Within the level-primitive AM camp there is no clear boundary between segmental anchoring and broader tonal/melodic alignment. Authors working in contour-primitive frameworks by contrast have argued against the existence of true segmental anchoring in favour of more general alignment of intonation with suprasegmental metrical structure. For instance, on the basis of statistical investigation of predictors of length of delay between syllable onsets and attainment of high pitch-targets in Mandarin, Xu (1998) argues in favour of the syllable as the minimum reference-domain for temporal alignment of pitch events.

Related to this is the temporal relationship between intonation and the typically assumed metrical prerequisite for its implementation: PLP. It is intuitively appealing to assume that a pitch event will have a straightforward temporal association with the PLP-bearing syllable to which it is associated. Though frequently true, this is not necessarily the case, as evident in Welsh intonation (Williams 1983, 1985, 1986; Cooper 2015: 46-55). In Welsh, the bulk of a pitch contour very frequently occurs on the syllable immediately following that bearing phonological lexical prominence. As discussed earlier in Section 2.1 with reference to 'stress deafness', this creates a situation in which judgements about PLP location by naïve English listeners often differ from those of native Welsh speakers (Williams 1986). Notably, this apparently unintuitive state of affairs can be resolved if the environment of an utterance is controlled for (Cooper 2015); phrase-level pitch-prominence does not *necessarily* occur post-PLP, rather in natural connected speech Welsh intonational phonology allows for a greater range of variability in alignment than monolingual English listeners are able to account for.

The above is a pertinent illustration of the danger in conflating real or perceived timing of intonational landmarks (such as high pitch) with PLP location. If one were to approach Welsh for novel documentation without prior knowledge of its phonology, using the high regions of falling accents as location diagnostics – at least without meticulous contextual control – would not produce a reliable description of PLP in the language. This is, in principle, not controversial for AM authors, who accept the need to distinguish pitch events from metrical structure at a lexical level even if in practice the two often overlap. However, there are obvious risks if one approaches an AM-style account of a language's intonation relying on PLP specifications which are themselves based on murkier conflations of salient pitch movement and PLP location. This risk looms large in work on Irish, and the Munster varieties in particular, as outlined in greater detail in Chapter 3.

It has further been suggested in the literature that visible turning points in estimated fundamental frequency are not ideal equivalents to phonological tonal targets, particularly given listeners' integrated perception of segmental information such as duration, sonority, and intensity and suprasegmental features such as intonation and voice quality. Barnes's and colleagues' (2012) *Tone Centre of Gravity* model of intonation posits that it is not turning points per se which best match theoretical claims about alignment of tonal targets, but rather the temporal 'centre' of a pitch event according to a weighted average of the area under a given contour. This is illustrated in Figure 4. Such an approach aims to account for perceptual judgements of identity between phonetically distinct pitch shapes which can be demonstrated to have roughly the same 'centre of gravity' in their respective contexts.

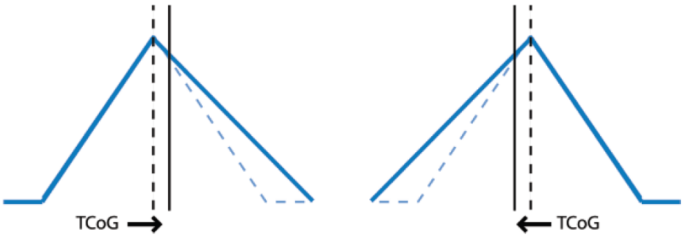

Figure 4 *Tone Centre of Gravity (TCoG) schematic extracted from Barnes* et al. *(2012).*

Similar to this is Rodgers's (2020) 'KMax' approach to intonation modelling, which uses a custom Praat plugin to combine turning-point specification with relative weighting of F0-contour portions according to periodicity in the waveform based on periodicity in the acoustic signal (with regions of greater periodicity being attributed more perceptual salience). This is used to produce resynthesised contours – such as that presented in Figure 5 – that, subject to perceptual comparison with the original, show a more meaningful representation of pitch events than simple estimation of F0 over time.

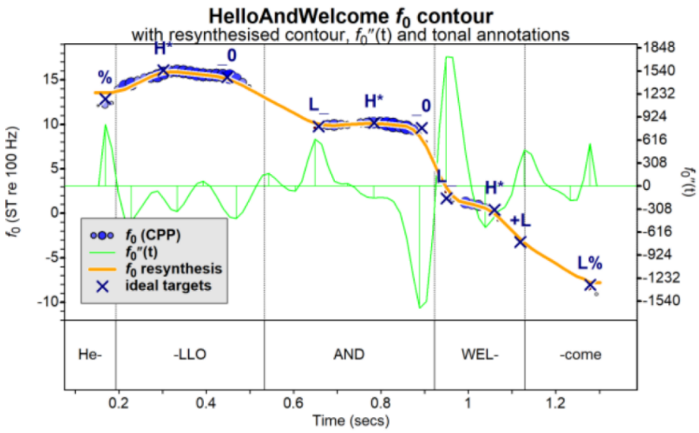

Figure 5 *Example of KMax plugin output extracted from Rodgers (2020). Periodicity of the signal is shown in blue in terms of* cepstral peak prominence *(CPP), a measure obtained by applying an inverse Fourier transform to the spectrum (hence* cepstrum *as the inverse). Greater point size indicates greater periodicity, taken to indicate regions of the contour in which F0 height and alterations will be most salient to a listener.*

Both of these approaches retain a broadly AM conceptualisation of intonational phonology (i.e. relying on the concept of level tonal targets), but in consciously overspecifying turning points bridge the gap between raw acoustic information and highly abstract phonological structure; labelled points are not claimed to necessarily correspond to phonological tonal targets, but are necessary as an intermediate step for accurate contour-description. This is shared with the transcriptional approach adopted in the investigation of Munster Irish intonation in Chapter 7, namely PoLaR ('Points, Levels, and Ranges'), which was developed for phonetic bootstrapping of intonational analyses by a team including several of the authors involved in the Tone Centre of Gravity model (Ahn, Veilleux & Shattuck-Hufnagel 2019; Ahn *et al*. 2021).

An illustration of PoLaR from Ahn, Veilleux & Shattuck-Hufnagel (2019) is provided in Figure 6. Intonational transcription proceeds from the identification of prosodically strong ('PrStr') syllables with <*> and salient turning points (TPs) in the F0 contour with <0>. Intonational phrase boundaries are also marked, using <]>. Overlaid onto these is a series of local F0 ranges for a given contour, intonational phrase, or utterance. These ranges are then used to calculate a TP's relative height as a level, obtained by dividing the range into equal portions. The default number of portions/levels is five. The particular adaptation of PoLaR used for the present work is outlined in Chapter 7. Relevant for general framing purposes here, however, is that by specifying visually salient turning points in the F0 track and specifying locally-defined F0 ranges, PoLaR allows for a general sketch of intonational events and a broad sense of relative scaling of TPs. This may be undertaken not necessarily as a replacement for later, more categorical phonological analysis, but as a preliminary step in organising and exploring intonation data.

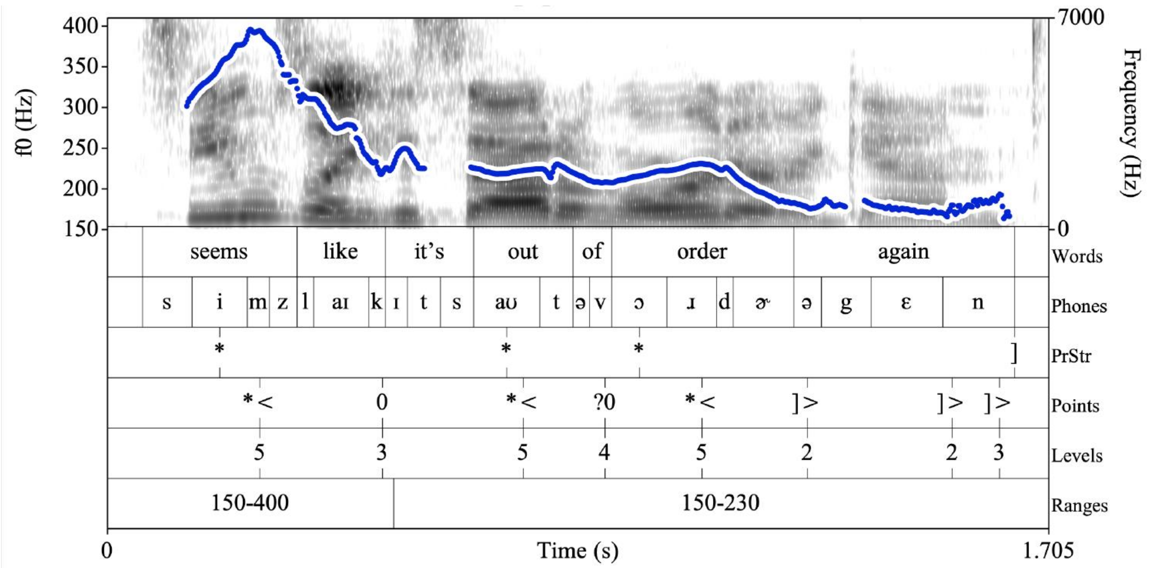

Figure 6 *Example of PoLaR annotation of intonation for the phrase 'seems like it's out of order again', extracted from Ahn, Veilleux & Shattuck-Hufnagel (2019). Prosodically 'strong' syllables (PrStr) and intonational phrase boundaries are marked on the third tier, TPs with additional diacritics on the fourth, F0 ranges on the sixth, and automatically calculated TP levels on the fifth.*

A resolution of ongoing debates surrounding the phonological specification and phonetic implementation of intonation do not fall within the remit of the questions of intonational alignment dealt with in this thesis (RQ3). The investigation of high-pitch coordination with PLP syllables in Munster Irish considered in relevant chapters below are not concerned with claims about productive phonological structure of phrase-level pitch events per se, so much as with the robust phonetic variability of high pitch with respect to PLP location, and the plausible (mis)perception of the latter. It is worth, however, being aware of this work's situation in the context of these controversies.

2.5 Chapter summary

This chapter has provided an overview of topics in prosody relevant for the present work. The most important of these, consequently covered in the greatest details, are the related concepts of phonological lexical prominence (Section 2.1) and syllable weight (Section 2.3). In the interest of moving away from perennial terminological ambiguity associated with the terms 'stress' and 'accent', I have specifically elected to refer to phonological lexical prominence (PLP) when discussing the abstract mark indicating the 'strong' syllable of a given word. I aim to situate my work on Munster Irish in the context of growing scepticism of traditional descriptions of PLP location sourced from grammars and impressionistic dialect descriptions. The latter typically rely on a vague and/or variably defined concept of PLP without taking into account (i) robust cross-linguistic differences in relative importance and phonetic implementation of PLP, and (ii) perceptual biases from a listener's L1. Both formal phonological and instrumental phonetic studies which implicitly trust the accuracy of these descriptions as prior information for their work are common, and this has largely been the case for studies of PLP and its correlates in Irish (and Munster in particular). The Irish-specific elements of this problem are outlined in Chapter 3, and together with the language-general topics of PLP and weight form the basis for RQ2 addressed in Chapters 5 and 6.

Related to the perception of PLP and weight are P-centres (Section 2.2) and intonation (Section 2.4), each vast topics in their own right. The P-centre is the point at which a listener perceives a sound to have occurred, the location of which is influenced by onset characteristics such as duration and structural complexity, and potentially by morphological derivation. It has further been suggested to play a role in processes previously attributed solely to the syllable rhyme, such as weight-reckoning and PLP placement. This is approached with RQ1 in Chapter 4's investigation of P-centres and Irish initial mutation (introduced in Section 3.4.1).

Within intonation, there is a broad theoretical division between camps which treat pitch contours (i.e. dynamic pitch events) as the most fundamental phonological unit of intonation, and those which instead decompose contours into discrete, level tonal targets which can be concatenated to form interpolated contours. Approaches based on phonetic identification of turning points in F0, such as PoLaR (Section 2.4.2), allow for an intermediate exploration of contour shapes and timing relationships. As briefly noted in Chapter 1, and discussed in greater detail in Chapter 3 below (Section 3.3.1), rightward movement of PLP in Munster Irish has been suggested to derive historically from a delay between heightened F0 and metrically strong/PLP-bearing syllables. The phonetic, TP-based approach to organising intonation data from this region in Chapter 7 using PoLaR allows one to address RQ3 without prematurely applying phonological labels to the contours in question.

3 BACKGROUND ON IRISH

In this chapter, I outline relevant information on Modern Irish, and the Munster macrovariety in particular, for the framing of the phonetic/phonological investigations described in Chapters 4-7. This begins with a cursory sketch of the historical context of the language's development, crucial for understanding its relationship with English and – of particular importance for treatment of phonological lexical prominence in the language – its multistratal lexicon, resulting from centuries of contact in varying measure with English, Norman French, Old Norse, and Latin. This is followed by a cursory description of the language's phonology and morphosyntax (especially the phenomenon of initial mutation). Within phonology, particular focus is devoted to work on lexical prominence and phrasal prosody in dialectology, philology, instrumental phonetics, and formal phonology.

3.1 Historical context

Modern Irish is a Goidelic Celtic language related to modern Scottish Gaelic and Manx (defunct as a community language by the turn of the 20th century, with traditional native speakers remaining until 1974; Ó Dochartaigh 1992) by common descent from Old Irish (roughly 600-900 A.D.) via Middle Irish (c.900-1200) and Early/Classical Modern Irish (c.1200-1650). More distantly, it is related to the surviving Brythonic Celtic languages Welsh and Breton (along with partially revived Cornish, which went extinct in the 18th century), with which it shares default Verb-Subject-Object word order and initial mutation; the so-called *Insular* Goidelic and Brythonic subgroups are estimated to have divided approximately 2000 years ago, prior to the Primitive Irish attested in stone carvings such as steles. Irish and the other Goidelic languages represent so-called *Q-Celtic* languages, in contrast with *P-Celtic*; this categorises Celtic languages according to their treatment of Proto-Celtic labialised velar stop *k^w as either /k/ or /p/ – contrast Irish *ceathair* with Welsh *pedwar*, cognate items both meaning 'four'. After the general adoption of Christianity in the 5th century A.D. and through the Middle Irish period up to approximately the 12th century, the language absorbed a number of loans from Latin (e.g. Modern *priacal* 'peril' from *periculum*, or Modern *eaglais* 'church' from *ecclesia*; McCone 1994; Breatnach 1994), as well as more limited borrowings from Norse and Old English (McManus 1994).

Historically, Irish was the primary vernacular language of the island of Ireland, and this situation persisted numerically until the Great Famine of the mid-19th century during which catastrophic death and dramatic emigration amongst the rural peasantry tipped the language's speaker base over the edge into minority status. This minority status, of course, is in relation to English. English was introduced to Ireland at multiple points in the late medieval and early modern periods as part of various waves of conquest, colonisation, and settlement from England. The earliest settlers to arrive from England were in fact (Anglo-)Normans, who spoke Norman French, but with them arrived contemporary Anglophones whose respective forms of Middle English were for a time preserved in regional Irish languages such as Wexford's Yola and Dublin's Fingallian.

During the English crown's Lordship of Ireland (c.1155-1542, beginning with Henry II on the basis of an alleged grant by Pope Adrian IV), cities/towns, settlements, and plantations associated with feudal lords contained substantial Norman French- and English-speaking populations (with the latter becoming more dominant as linguistic Anglicisation spread through the Norman ranks in Britain and Ireland). This was particularly pronounced in Munster and Leinster, with limited Norman influence in Connacht and virtually none in Ulster (O'Rahilly 1932: 87). Given the split in practical sovereignty between the Lordship based in the Pale (the area surrounding Dublin and Wicklow) and native Gaelic chieftains, bi- and multilingualism in both communities was common; indeed, the first wave of Norman settlement became linguistically and culturally Gaelicised by the 14th century (O'Rahilly 1932: 87; McManus 1994). During this period, Irish absorbed many loanwords from Norman French (cf. *garsún* 'boy' from *garçon* of the same meaning; O'Rahilly 1932; McManus 1994).

In 1542, in the aftermath of the severance of ties with the Roman Catholic Church as part of the English and Irish Reformations, England's Henry VIII was declared King of Ireland by the Irish Parliament in Dublin (previously not permitted by the papacy). It was Tudor Ireland that saw the collapse of the remaining Gaelic aristocracy with the Flight of the Earls in 1607. With the totality of the island now at least nominally under unified control of the Crown, the Irish language found itself somewhat more marginalised. Under heavy legal pressure, the language was excluded from much of public life (Williams 1986: 9). Limited religious exceptions to this emerged in the established Church of Ireland with Henry's daughter Elizabeth I, who specifically appointed Irish-speaking clerics to high-ranking positions and allowed for public prayer, preaching, and sacramental administration in Irish where locally required. Elizabeth expressed a desire to learn Irish as a language of one of her realms; it was under her that the first books to be printed in Irish – a (Protestant) catechism, and slightly later the Book of Common Prayer (*Leabhar na hUrnaí Coitinne*) – were published and distributed, and her 1592 foundation of Trinity College was at least nominally to train Anglican clergy for proselytization of the Roman Catholic population in their native language.

A number of prominent members of the established Church following reformation were highly accomplished Irish scholars, such as James Ussher (Archbishop of Armagh), and Englishman William Bedell (briefly Provost of Trinity College, and later Bishop of Kilmore and Ardagh;

Williams 1986: 43-45), and as late as the mid-18th century sermons in Dublin's St Patrick's Cathedral required interpretation into Irish for much of the congregation (Bolton 1958). However, as a result of politics, economics, legislation, and undoubtedly virulent anti-Gaelic colonialism, from the Tudor period onward Irish was on the back foot and would never regain the sociolinguistic prestige it had enjoyed in Gaelic Ireland.

In a lengthy shift spanning several centuries, Irish became associated with rural peasantry and low social capital, although it retained a numerically and transmissionally robust speaker base. The language remained vital, particularly in the west of the country, with a rich literary tradition continuing into the early 19th century and ample evidence of urban-based or -linked speaker communities, including in the middle merchant classes of the 18th century, in places such as Cork and Galway (cf. the 1773 *Caoineadh Airt Uí Laoghaire* ['Keening of Arthur O'Leary'], composed orally by mourning members of an extended merchant- and military family network in County Cork, and one of the longest orally transmitted poems ever recorded in a modern European vernacular).

The decline of the language was sharply affected by the Great Famine of 1847-48 (with pronounced impact for several years following), in which the population of the island no less than halved as a result of starvation and mass emigration driven by economic devastation. During this period, Irish absorbed a great number of loanwords from English thanks to prolonged, multigenerational bilingualism and the inevitable cultural and political force of English on the island. It is estimated that of the 1.5 million Irish speakers recorded in the 1851 census – roughly a quarter of the immediately post-Famine population – some 80% had practical knowledge of English (Ó Dochartaigh 1992). Considering that half of the population were native Irish speakers – of which many were monoglots – in an 1812 estimation (Oireachtas Library & Research Service 2016), this change in the span of less than 40 years is particularly striking.

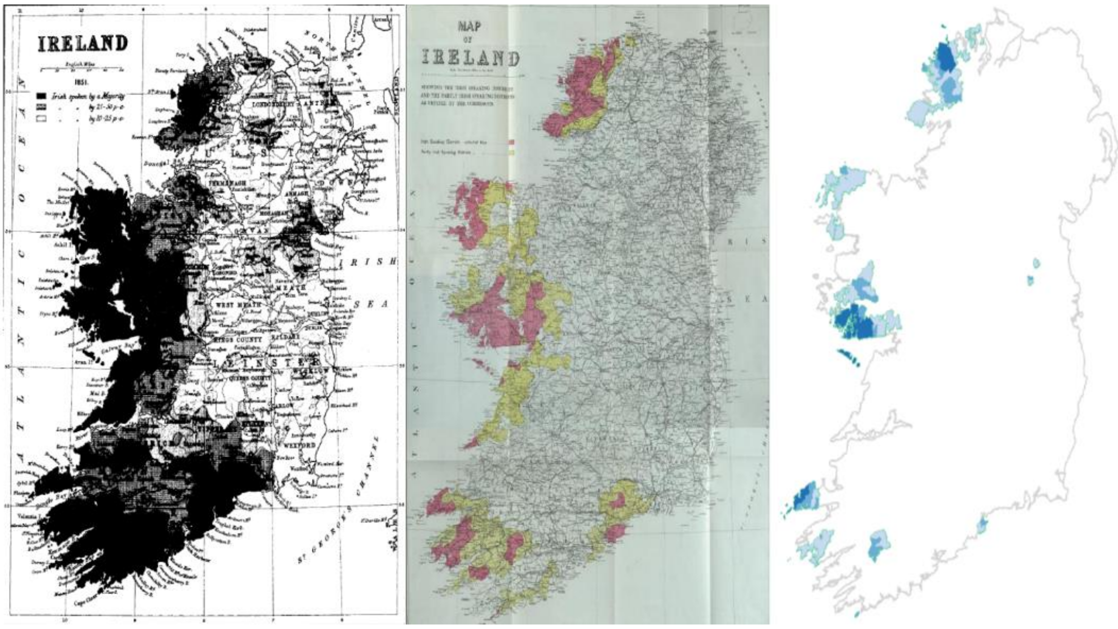

Figure 7 *Decline of the Irish language from an estimate in 1851 (L) to the enumeration of the Gaeltachtaí in 1926 (C) to the 2011 census (R) (Oireachtas Library & Research Service 2016)*

With a non-mobile and often illiterate majority speaker-base, and no central prestige variety associated with governmental or cultural power, existing regional variation in Irish continued to diversify (Williams 1994). Until the 17th century, a centralised prestige variety associated with the highly institutionalised bardic tradition dominated the literature which represents the vast majority of texts from the Middle and Classical Modern periods of the language (Ó Dochartaigh 1992; McManus 1994). Present-day regional varieties of Irish are generally mutually intelligible, but exhibit notable diversity in lexis, phonology, and morphosyntax.

Modern Irish is spoken as a community language in the legally-defined *Gaeltachtaí*, which in 2016 had a total population of just under 30,000 people who reported speaking Irish daily outside of the education system (Oireachtas Library & Research Service 2016). The language can be divided into three regional macrodialects, as illustrated in Figure 8, with no spoken standard (despite a written standard – *An Caighdeán Oifigiúil*), and there is further variation present within the broadly geographically-defined dialect regions of Ulster (Donegal Gaeltacht), Connacht (Galway and Mayo Gaeltachtaí), and Munster (Kerry, Cork and Waterford Gaeltachtaí). This division is very general, and the reality is more gradient (e.g. Ulster-like features in some northern Connacht varieties, or Munster-like features in some southern Connacht varieties). The Munster variety, the focus of the present thesis, is the numerically sparsest of the three with remaining speaker communities in the Gaeltachtaí of Counties Kerry, Cork, and Waterford, as shown in Figure 9. Irish, in all its forms, is classified by UNESCO as 'definitely endangered'.

Figure 8 *Map of present-day Gaeltachtaí from the 2016 Census, with three macrovarieties (Ulster, Connacht, and Munster) indicated. The small regions near Dublin are Ráth Chairn and Baile Ghib in Co. Meath, Gaeltachtaí created in the 1930s by state-incentivisation of Irish-speaking families, most from Connemara, to move east.*

Figure 9 *Munster Gaeltachtaí in Kerry (Corca Dhuibhne, Uíbh Ráthach), Cork (Múscraí, Oileáin Chléire), and Waterford (Rinn Ua gCuanach, An tSean Phobal).*

On the back of sociopolitical and ethnocultural revivalism associated with the pre-independence Gaelic Revival and Conradh na Gaeilge (a.k.a. the Gaelic League, established 1893) in particular, Irish was declared the 'national' and first official language of the Republic of Ireland in the 1937 Constitution. As part of its public status, the language is taught as a compulsory subject in primary and secondary education. Further, as of 1 January 2007, Irish became an official and working language of the European Union (the derogation period for the full implementation of which was completed 15 years later on 1 January 2022; Translation Centre for the Bodies of the EU 2022). These legal acknowledgements have lent the language an official prestige, but one which is not matched by stable transmission of the language as a daily community language.

In the 2011 census, out of a population of over 5 million, less than 80,000 in the Republic of Ireland self-identified as 'daily' Irish speakers outside of the education system, and of the 154 electoral districts comprising the various Gaeltachtaí, only 18 have 75% or more daily users of the language (An Coimisinéir Teanga 2022). Bilingualism with English is now virtually universal amongst L1 Irish speakers, and English exposure is further amplified in the present day by the language's omnipresence in the digital world via broadcast and social media. Revival efforts outside the Gaeltacht variably receive support from fully or partially Irish-speaking households (including speakers of Gaeltacht varieties), L2 learners of diverse ages in English-medium schools and/or classes, and those who have gone through Irish-medium education (*Gaeloideachas*) – notable for its ever-growing popularity. The linguistic features and practices characteristic of urban Irish are interesting in their own right, but they are often distinct from those of the traditional Gaeltacht varieties immediately relevant for the present work (see, e.g., Ó Broin 2014). This distinction is of course gradient rather than categorical, and sociolinguistically complex; non-Gaeltacht speakers (L1 or otherwise) with largely traditional Irish can be found, as can Gaeltacht speakers with non-traditional features.

In short, over the course of its 1.5 millennia of recorded history, the Irish language has – like all living languages – experienced a great deal of change. Its lexicon reflects notable borrowing from Latin, Norman French, Old Norse, and various stages of English as a result of prolonged contact during the Old, Middle, and Modern Irish periods. Dramatic and at times draconian British colonialism from the 16th century onwards, accelerated by the seismic tragedy of the Great Famine in the mid-19th century, led to the language's decline as a majority community language in favour of a shift to English. Irish is now an endangered language, with decreasing rates of intergenerational transmission as a mother tongue, and is subject to inescapable and arguably suffocating contact with English (primarily Irish English varieties, but also with less direct exposure to international prestige varieties from the USA and UK). The future of the language is, at best, uncertain. In light of these sobering facts of language decline, at least as regards the traditional and historically continuous forms of the language represented by the Gaeltacht varieties, the importance of systematic data collection and scientific study should be clear. In the remaining sections of this chapter below, I outline basic principles of Irish phonology and morphosyntax.

3.2 Segmental phonology

The Irish consonant system is characterised by a contrast between a robust and lexically contrastive palatalisation/velarisation system which extends across the entire consonant inventory (Ó Siadhail 1989: 83; Ní Chasaide 1995). Traditionally, these contrasting series are referred to as *caol* 'slender' (palatalised) and *leathan* 'broad' (non-palatalised and often velarised); this terminology has the advantage of making no explicit claims about the phonetic realisation of the contrast without disregarding their opposition (Ó Siadhail 1989: 9-10, 83). The opposition is applicable in all word- and syllable positions, and is relied upon for both basic lexical contrasts and morphosyntax (e.g. distinguishing a given lexical item’s nominal and genitive forms and/or singular and plural forms). Compare, for example, minimal pairs such as /bˠoː/ ɑ *bó* ‘cow’ – /bʲoː/ *beo* ‘alive’ or /bˠɑːdˠ/ *bád* ‘boat’ – /bˠɑːdʲ/ *báid* ‘boats’. The contextual implementation of the slender/broad distinction varies by speaker and variety, as well as by function of context (e.g. it may be stronger in syllable-initial position; Ní Chiosáin and Padgett 2012). It is also supported by secondary cues, such as dentalisation of broad coronal stops or conditioned diphthongisation of adjacent vowels (Ní Chiosáin and Padgett 2012). The majority of slender/broad consonant contrasts are indicated in transcription by a superscript <ʲ> or <ˠ>, while others may receive distinct characters entirely (e.g. broad /s/ <s(ˠ)> vs. slender <ʃ>).

There is a voicing opposition for stop consonants (/pˠ pʲ tˠ tʲ kˠ kʲ bˠ bʲ dˠ dʲ gˠ gʲ/), although note that, as has been observed for Scottish Gaelic (Ladefoged et al. 1998) and English, this contrast is often phonetically realised as aspiration/pre-aspiration and a lack thereof, as has been documented acoustically in Donegal by Ní Chasaide (1985) and in Connemara by Ní Chiosáin & Padgett (2012). In addition to the aforementioned stops, the language uses alveolar and bilabial nasals, alveolar, velar, and labiodental fricatives, and a qualitatively variable rhotic (typically either an alveolar trill/tap or an English-like approximant).

Historically, Irish also distinguished between so-called ‘unlenited’ or ‘tense’ and ‘lenited’ or ‘lax’ pairs in its sonorant series (i.e. /rˠ rʲ l lʲ mˠ mʲ nˠ nʲ/), traditionally notated as unlenited/tense <R R’ L L’ M M’ N N’> and lenited <r r’ l l’ m m’ n n’>. This distinction was robust in Old Irish, although its orthographic representation was not always explicit (McCone 1994); unlenited/tense sonorants may be signalled by a doubled grapheme (e.g. <ll> or <nn>) – something which holds in the modern language (e.g in the suffix *-lann* signalling a place or venue) – but this is not the case for the full sonorant series as it excludes /mˠ˜ʲ/ and is further restricted to syllable-final position. The opposition
had collapsed in all dialects but that of Donegal by the time of modern descriptions (cf. Quiggin 1906). The phonetic character of this distinction is difficult to pin down, but can be broadly said to involve relative ‘strength’ of articulation as represented by acoustic extremity, duration, and resistance to coarticulation (Ní Chasaide 1977). By the time of Ní Chasaide’s (1977) acoustic investigation of Donegal’s conservative four-way lateral system (/Lˠ Lʲ lˠ lʲ/), it is apparent that the lenition contrast was, if not moribund, under pressure[4]. Further, unlenited/tense sonorants have

[4]A 3-way contrast may still be produced by some modern Connacht speakers (Ní Chasaide, p.c.).

conditioned certain sound changes in the language. Waterford Irish, for example, is characterised by extensive diphthongisation before historically unlenited/tense sonorants. This yields forms such as /kʲaɪnʲ/ for *cinn* 'heads' instead of the /kʲiːnʲ/ or /kʲɪnʲ/ found in other varieties.

With regard to vowels, Irish is typically described as having 10 contrastive categories, deriving from five qualities /i e a o u/ and a robust binary length contrast (Ó Dochartaigh 1992; Ní Chasaide 1995). Schwa and other centralised/reduced vowel qualities also occur frequently, although their precise phonological status is a matter of debate; the distribution of schwa is typically described in tandem with that of PLP (e.g. Ó Dochartaigh 1992 §2.12 and §2.14.1), raising questions about its status as a full part of the vowel system versus as a reduction of other vowels conditioned by a lack of prominence. Depending on varietal considerations, vowel quality and quantity may be affected by phonological lexical prominence and/or by surrounding segmental context. See for example, the diphthongisation before historically tense sonorants mentioned above for Waterford, or the raising of nasal-adjacent /o/ to /u/ in many Connacht and Munster varieties (Ó Siadhail 1989: 42-43).

Consonants and vowels can be combined to form syllables ranging from extremely simple vowel-only structures (e.g. *a* 'his/her/their' or *i* 'in') to complex structures with consonant clusters of up to three members in both onset and coda positions.

3.3 Prosody

I come now to the most important area of Irish phonology for the present work: prosody. As previously noted, Munster varieties are said to be set apart from other Irish varieties in terms of their prosody, and most notably lexical-level prosody. This section builds on prosodic concepts introduced in Chapter 2. It begins with a framing of open questions in lexical prominence in Section 3.3.1, and then turns to phrase-level intonation in 3.3.2.

3.3.1 Lexical prominence

At this juncture, it is useful to highlight once again the importance of terminological clarity. Previous treatments of Irish PLP in the philological, dialectological, and linguistic literature have referred generically to their object of study as both *béim*/'stress, emphasis' and *aiceann*/'accent' in Irish- and English-language writing, and this occurs in potentially conflicting conjunction with discussion of phrase-level prominence and intonation for which the same terms can be used. As sufficiently illustrative (but by no means exhaustive) examples, O'Rahilly (1932) discusses 'stress' in chapters respectively titled 'The *Accent* in [Northern/Southern] Irish', Thurneysen (1946) discusses ‘stress’, Ó Sé (1989) discusses ‘stress accent’, and McCone (1994) discusses *béim* ‘stress’ as contrasted with *neamhaiceanta* ‘unaccented’ syllables.

This is precisely why I have elected to refer to ‘phonological lexical prominence’ in contrast to phrasal prominence(s). Because these terms are rarely given explicit definition (and often rely on written records, particularly for retrospective philological work on Old and Middle Irish), the phonetic exponence and underpinning phonological structure of their referents remain opaque. Formal phonological attempts to account for PLP location in Munster Irish have overwhelmingly assumed 20th-century descriptions of the feature, taken to be authoritative, and proceed to construct theoretical frameworks that unite apparently conflicting PLP locations using formal phonological mechanisms such as rule ordering or Optimality-Theoretic constraints. I feel, however, that it is of great importance to thoroughly interrogate these pre-formal descriptive sources, their authors’ backgrounds and terminological preferences, and their compatibility with the theoretical frameworks into which they have been assumed as ‘data’. As such, in this section I first outline the development of philological and dialectological PLP description for Modern Irish (and Munster in particular) before proceeding to more recent formal approaches to the topic.

Old Irish located PLP in initial position in virtually all cases, evidence for which is inferred primarily from durational reduction and/or total syncope or apocope of non-PLP syllables in words inherited from Primitive Irish (Thurneysen 1946: 27, 31, 67; Ó Sé 1989). There were systematic, if limited, exceptions to this for (i) certain types of verbal compounds (with prefixed prepositions), and (ii) nouns, adjectives, and adverbs deriving from historical compounding. In these so-called *deuterotonic* cases (from Greek *deutero-* ‘second’ and *tonic* indicating prominence), PLP occurred in second position (Thurneysen 1946: 27-30); long vowels in non-PLP syllables were rare in Old Irish, occurring mainly in loanwords (Ó Sé 1989; McCone 1994). The role of PLP in this stage of the language is typically said to have been demarcative (Ó Sé 1989), which would make for a fixed, edge-based, and perception-facilitating PLP system in line with the Prague School’s canonical model as outlined in Section 2.1 above.

As noted, the meaning of PLP – however it is termed by a given author – is generally taken for granted. For textual evidence, there is little more than this to be done in the absence of contemporary metalinguistic description which, to my knowledge, is not attested in the available evidentiary sources for Old Irish; inferences drawn from, e.g., non-PLP syllable reduction and treatment of loanwords must suffice. This situation of initial PLP persisted through the Middle Irish period (900-1200) into at least the Early Modern period, during which it is interesting to note that the contemporary poetic metres *dán díreach*, *oglachas*, and *bruilingeacht* make no reference to PLP or its distribution across lines, or indeed to syllable structure/weight. Rather, they rely entirely on syllable counting. This contrasts with PLP-based metres in, e.g., Latin, and English, or weight-sensitive metres in, e.g., Greek and Sanskrit, and calls into question the relative importance of PLP (beyond the already mentioned demarcative function) in the Irish language up to this period. On the other hand, it should be acknowledged that sources for Middle and Early Modern Irish are dominated by bardic literature which may not be representative of contemporary vernacular speech (O'Donovan 1845: lxxi-lxxiii).

Differential treatment of PLP and its practical implementation characterises the modern varieties of Irish. In general, Connacht and Ulster Irish are said to have retained the Old Irish system of PLP in initial position with limited lexical exceptions. Munster, meanwhile has developed a divergent system in which PLP frequently occurs in non-initial position. Even this generalisation is an oversimplification of the facts on the ground. Grammatical and lexicographical treatises of the 17th-19th centuries make passing reference to Munster's prosodic idiosyncrasies (e.g. Donlevy 1742, quoted in O'Donovan 1845:lxxvii-iii, "The grand difference between the dialects…consists in the position of the accent…The Munster dialect is…remarkably distinguished…by throwing the primary accent on the second or third syllable when long."), but others do not restrict the attribution of this feature to Munster so much as to a range of broadly 'southern' varieties (including parts of Leinster and Connacht). The exact nature of the 'throwing forward' is unclear, as are (i) the structural conditions for its application, and (ii) the geographical extent of the phenomenon.

O'Donovan's 1845 *Grammar of the Irish Language* appears to contain the earliest systematic treatment of PLP in the language, and indeed is acknowledged by O'Rahilly (1932: 13) as a seminal work in the study of Modern Irish. In his discussion of 'accent' ("…that which distinguishes one syllable in a word from the rest," p.403), O'Donovan refers to a tendency in southern varieties of Irish for "nearly equal" prominence on the first two syllables of di- and trisyllabic words if both syllables contain long vowels, possibly favouring the second syllable (p.404). This he frames more in terms of a *lack* of the quantity/quality reduction in non-initial (i.e. non-PLP) syllables attested in northern varieties (mainly Ulster), and notes the cross-varietal metrical incompatibility of post-bardic/Classical poetry (pp.404-405). To this, he adds a list of nominal suffixes which exhibit this lack of final reduction and may bear prominence, regardless of previous syllable content, such as the agentive suffix *-óir*/*-eoir* (pp.405-406). Items deriving from polysyllabic roots, however, are described as having uniform initial PLP in all varieties.

Following intervening grammatical and dialectological treatments such as Molloy (1867) and van Hamel (1926), T.F. O'Rahilly's 1932 *Irish Dialects Past and Present* presents the next key source for the description of PLP in Irish, the treatment of which he divides into two chapters for 'northern' and 'southern' varieties. O'Rahilly equates 'accentuation' and 'stress' – neither of which is given definition for phonetic value or phonological role – and regards Irish as "a language with strong stress" (p.84) which disprefers long syllables in the absence of PLP. Due to its influential status and its representation of contemporary thinking on PLP in early-20th-century Irish dialectology, his summary description of "the accent in Southern Irish" (pp.86, 92) is worth quoting at length:

> *"Southern Irish throws forward the stress to the second syllable of a word whenever that syllable is long, e.g.* cuileá·n[5], arú·r *(*<arbhar*),* ógá·nach, díomhaoi·n. *Furthermore, the third syllable, if long, attracts the stress to itself when the two preceding syllables are short, e.g.* spealadói·r. *When the second syllable is stressed and does not contain* í *or* ú*, a short vowel in the first syllable is weakened and obscured, so that pretonic* a, o*, and* u*, are all pronounced alike, e.g.* casóg *is pronounced* cəsó·g*; similarly* faisnéis *is pronounced* fuisné·s*, and* spriosán *is pronounced* spriosá·n. *Short vowels frequently disappear from the first syllable of a word when the second syllable is stressed and begins with* l, n*, or* r*, e.g.* coláiste*…"* O'Rahilly 1932: 86

> *"Occasionally the stress is attracted to a short vowel in the second syllable. In Munster Irish this occurs especially in connection with the syllable* ach*…Under the influence of neighbouring words the stress of certain words is liable to be modified in any or all of the dialects."* O'Rahilly 1932: 92

The geographical extent of this 'forward stress' (i.e. non-initial PLP) is described as permeating Munster and reaching into Dublin, Kildare, Offaly, southern Meath, and southern Galway, with limited, lexically-specific cases in Connacht and northern Leinster. This is attributed to the influence of Norman French in the regions, based on final PLP in contemporary and modern French; Norman plantation, settlement, and administration more heavily affected Munster and Leinster (particularly in and around Dublin, i.e. the Pale). According to O'Rahilly (p.87-89, 109-112), a combination of vast lexical borrowing from Norman French, and analogical extension of PLP placement based on the same best explain the non-initial PLP pattern of Munster and adjacent varieties.

Here it is interesting to note that, at least for Modern French, PLP is in fact considered to be of little importance for phonological/lexical contrast, with some scholars arguing that the language has no lexical-level prominence at all. Instead, high pitch and increased duration are used to mark

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[5] O'Rahilly uses <·> to indicate prominence of the syllable it follows.

the final syllable of each ‘accentual phrase’, regardless of the number of syllables or lexical items in said phrase (Gussenhoven 2004: 253-273; Fournier 2007; van der Hulst 2014; Michelas & Dufour 2022). Further, it has been noted that written evidence of non-initial PLP does not emerge until several centuries after the advent of contact between these varieties and Norman French although, admittedly, the dominance of stylised Classical bardic language in the Early Modern period may well obscure the contemporary vernacular situation (van Hamel 1926; Ó Sé 1989).

In any case, the most relevant points from O’Rahilly’s treatment of PLP in southern Irish varieties are: (i) his accounts are either personally impressionistic or derived from textual analysis, (ii) his conflation of ‘stress’, ‘accent’, and ‘tone’ make it virtually impossible to distinguish his perception of lexical- and phrase-level prominence and of the phonetic exponents thereof, (iii) second-syllable long vowels are said to attract PLP (e.g. *casóg* ‘cassock’), as does second-syllable /ax/[6] when the a word contains no long vowels (*gealach* ‘moon’), (iv) in words of three or more syllables, third-syllable long vowels are said to attract PLP when the first two syllables contain short vowels (e.g. *achainí* ‘petition’), and (v) variable final PLP is noted to occur in all Irish varieties for certain function words such as *agam* ‘at me’ or *orm* ‘on me’.

The principles laid out in O’Rahilly (1932) are essentially consistent with dialect descriptions undertaken in the subsequent decades (of which I focus on Munster cases). Ó Cuív (1944) describes ‘stress’ (defined vaguely in terms of “breath-force”; p.63) in County Cork’s West Muskerry[7] (a.k.a. Múscraí) being attracted to peninitial syllables with long vowels, with the specific exception of cases arising from verbal inflection and scattered lexical exceptions (e.g. *baitsiléir* ‘bachelor’, an obvious English loan; p.65). Second syllables containing /ax/ attract PLP in the absence of a long vowel (e.g. *gealach* ‘moon’), also with various lexical exceptions (e.g. *Connacht*; p.66). Compound words are also noted to receive PLP treatment based on their speaker-perceived transparency of derivation and the particular syllable counts and structures of their component parts (pp.67-68). He goes on to describe ‘sentence stress’ in the variety (i.e. phrasal prominence; pp.68-70), yet another mark in favour of transparent (if cumbersome) terminology for the purposes of this work. Breatnach’s (1947) description of the Ring (An Rinn) variety of County Waterford is virtually identical, including derivational verbal and lexical exceptions, and separate treatment of ‘sentence stress’ (pp.77-88).

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[6]Unless derived from <-adh>, as in verbal forms such as *mholadh* /ˈvˠɔlˠax/ ‘would praise' (O’Rahilly 1932: 110).

[7]Ó Cuív’s two primary informants for his study of this variety, Amhlaoibh Ó Loingsigh and Domhnaill Ó Céilleachair, are included in the 1928 Doegen Records (see Chapter 5). The same is true for two of Breatnach’s (1947) three informants from An Rinn in Co. Waterford: Mícheál Turraoin and Mícheál Ó Cinn Fhaolaidh. These are participants AÓL, DÓC, MT, and MÓC in the list of Doegen speakers examined in Chapters 5 and 7.

Regarding the now-extinct Irish varieties of County Clare, Holmer (1962) distinguishes between Clare Irish "proper" and those varieties which border County Galway (p.63). The former are said to exhibit the 'Munster Irish' PLP system, specifically as described by O'Rahilly (Holmer 1962: 63), with the qualification that words longer than disyllables (i.e. three syllables or more) are challenging for concise, rule-based description. The relative strength of PLP-attraction in trisyllables with more than one long vowel is apparently particularly controversial, with initial prominence obtaining for long-short-long words, but peninitial prominence emerging if there is a long second syllable. Similarly, he describes that trisyllables of the type short-short-long more often have initial PLP than final (p.64). The tendency of /ax/ to attract PLP is limited to this sequence's occurrence in a second syllable in the absence of any long vowels in the word, but even this is variable and limited to the southernmost varieties of the county (p.65). A similar state of affairs is described for the neighbouring Kerry variety of Baile Dubh, also now extinct, by Ó hAnnracháin (1964), including the preference for initial prominence in long-short-long trisyllables (pp.30-31).

The question of Munster Irish PLP was first connected to formal phonological literature and questions of phonetically plausible historical development by Virginia Blankenhorn in 1981, who favours the term 'forward stress' to refer to the phenomenon. Blankenhorn is, as far as I am aware, the first author in the Irish literature to make explicit her assumptions about the phonetic exponence of PLP, which she takes to include intensity, duration, and increased pitch, acting in concert. Beginning with O'Rahilly's (1932) work as a descriptive point of departure, she proceeds to suggest an explanation based on intonational alignment. She also emphasises the frequent coexistence of shifted and unshifted forms of individual lexical items previously pointed out by O'Rahilly (1932: 93) and Sjoestedt-Jonval (1931).

On the basis of Ó Cuív's (1944) description of high-pitch peaks occurring one or more syllables after metrically strong syllables in Múscraí (Cork) Irish (returned to in Section 3.3.1 below), Blankenhorn suggests that sometime in the early Modern period Munster Irish speakers reanalysed frequent occurrence of high pitch on the syllable following historical initial PLP as marking right-shifted PLP, thereby actuating such a change in their own production. The parallel between this hypothesised situation and the intonational alignment characteristic of Welsh (Section 2.4.2) is explicitly acknowledged.

In short, Blankenhorn's suggestion is that high pitch associated with phrase-level intonation (as opposed to lexical-level PLP-marking), ambiguously aligned with non-initial syllables containing long vowels (particularly Norman loanwords), was interpreted as non-initial PLP; this 'Munster' system then spread from varieties with pronounced intonational 'misalignment' to neighbouring varieties that did not themselves exhibit such robust ambiguity in lexical prominence (though see the disclaimer about linking high pitch and perceptual salience in 3.3.2 below). The exceptional behaviour of /ax/ is attributed to its resistance to vowel-reduction in non-PLP syllables, and final PLP in limited short-short disyllables such as *turas* 'trip' or *tirim* 'dry' is linked to frequency. In effect, this proposes a listener-driven, phonetically natural sound change in the spirit of Ohala (1981, 1989, 1993). The timing relationship between high pitch and PLP/metrically strong syllables (RQ3) is examined in Chapter 7.

Shortly following Blankenhorn's 1981 paper, Ó Sé (1989) provided a geographical and lexicographical study of PLP location in various Irish varieties which exhibit some form of non-initial PLP, with a particular emphasis on Munster. While acknowledging that instrumental phonetic work is required to confirm this, the stipulation is made that 'stress accent' is cued by pitch, duration, and intensity. Further, Ó Sé appears to be the first author to explicitly refer to syllable weight in connection with Irish PLP, as opposed to reference to 'long' and 'short' vowels and syllables in preceding scholarship. He classes syllables with a long vowel, diphthong, or /ax/ as heavy, and those with only a short vowel as light. Mustering varietal evidence of non-initial PLP ranging from extensive to scant from Kerry, Galway, Mayo, Kilkenny, and Laois, Ó Sé discusses evidence for the feature's historical origin and contemporary extent.

Ultimately, PLP in 'stress-shifting' Irish varieties most heavily represented by Munster is summarised by Ó Sé as: (i) *culminative* (i.e. signalling locationally variable prominence) rather than *demarcative*, using Trubetzkoy's (1969: 277) terminology, (ii) weight-sensitive, (iii) restricted to the first three syllables of a word as a 'stress domain', and (iv) occurring on a "rightward heavy syllable" when applicable with initial PLP as a default. Typological comparisons are drawn between PLP assignment in these varieties and the weight-sensitive systems of Punjabi as described by Garde (1967: 99-100; 1973), Selkup as described by Halle & Clement (1983: 189), and Classical Latin. The author emphasises that "a thorough study, using laboratory techniques, of the suprasegmentals … of … Modern Irish … is indispensable to further progress" on the matter of PLP in Irish, and it is my hope that the present work contributes to this end.

It was this body of work which was taken as an ostensibly complete and authoritative description of a monolithic system of PLP assignment by a series of formal phonologists beginning in the 1990s. Foundational dialect descriptions and language-general texts from the 19th century through the 1960s described the location of prominence (lexical, phrasal, both, or without specification) on the basis of textual evidence and personal impression. Papers in the 1980s by Blankenhorn and Ó Sé combined philological and dialectological work in this vein with contemporary concepts in linguistics (particularly phonology) to approach generalisations about the nature of PLP in southern

Irish varieties, and to hypothesise about the origin of non-initial PLP in said varieties. It is here worth emphasising the meticulous character of this scholarship, which required – in addition to native or native-like familiarity with the modern language – extensive knowledge of Old, Middle, and Classical Modern Irish. Additionally, the dialect descriptions of the 1940s-60s approached the non-prescriptive description of local phonology (or, in some cases, pre-phonological phonetics), morphosyntax, and lexis nearly *ab initio*. The incompatibility of much of this work with the formal phonological theorisation for which it has often been used as 'data' is an entirely distinct issue.

This incompatibility derives from ambiguous terminology surround PLP, vagueness in the treatment of lexical versus phrasal prominence, acknowledgement (or lack thereof) of competing 'shifted' and 'unshifted' forms in several varieties, and a lack of clarity regarding the relationship between PLP in described lexical items (or classes of items) and the concept of 'productivity' of PLP assignment (see Section 2.1.1 above). The latter seems particularly crucial, given generative formal phonological accounts' main desideratum: identifying how PLP is *derivatively assigned* to lexical items with reference to their segmental structure and/or morphology. I consider representative cases of such formal phonological approaches below before concluding this section.

The formal phonological interest in non-initial PLP in southern varieties was initiated by Cathal Doherty with his 1991 paper 'Munster Irish stress' at the 10th West Coast Conference on Formal Linguistics at Arizona State University. Doherty's "stress facts" are taken from O'Rahilly (1932) and the dialect descriptions of Ó Cuív (1944) and Breatnach (1947). Unlike Ó Sé (1989), he explicitly attributes an intermediate weight-status to syllables containing /ax/, but only when it falls in second position. Notable in the first place is the conflation of all varieties described as exhibiting non-initial PLP into a single proposed system, and the failure to acknowledge variability in described PLP location within varieties. Instead, the 'facts' are presented without direct reference to their individual provenance and as authoritatively representative of the whole of Munster Irish.

From the selected PLP patterns, Doherty builds an analysis couched in terms of bimoraic trochees (left-headed feet comprising two morae; heavy syllables contain two morae while light syllables contain only one) and a restriction on the adjacency of feet. Foot-construction proceeds from the left edge of a word, applying to the initial syllable and to all heavy syllables. An 'extrametricality' rule is proposed whereby initial syllables are excluded from consideration for PLP-assignment if they are immediately adjacent to another foot (i.e. if a heavy syllable occurs in second position). PLP occurs on the head of the leftmost foot to survive this process of extrametricalisation. The exceptional weight-status of /ax/ is derived from its marking as a "non-optimal" weak constituent in a disyllabic foot. Importantly, this is the first instance in which Munster/Southern Irish non-initial PLP was marshalled as evidence with bearing on competing theories of cross-linguistic phonological structure, namely the nature of metrical structure, and the construction-requirements of feet and the possibility of restriction on their adjacency. This is also the first case of initial syllables being suggested to be somehow defective, rather than simply not bearing PLP in a number of structurally- or etymologically-determined cases.

Shortly thereafter, Green's (1997) PhD *The prosodic structure of Irish, Scots Gaelic, and Manx* took an Optimality-Theoretic (OT) approach to Munster PLP. Similar to Doherty (1991), he begins by presenting "data" taken from dialect descriptions, though unlike Doherty acknowledges in a footnote the existence of lexical and derivational-morphological exceptions to the patterns described (p.121). Green's 'solution' to the problem of non-initial PLP in Munster is a series of OT constraints which prioritise, amongst other things, a link between weight and PLP, supplemented by reference to a level of the prosodic hierarchy intermediate between the foot and the prosodic word: the colon (originally proposed by Hayes 1995: 119). For the Munster case, the colon is claimed to be binary (i.e. comprising two feet) and right-headed, in contrast to the left-headed (i.e. trochaic) character of its immediate constituent (the bimoraic foot). Non-initial PLP in Munster Irish, East Mayo Irish, and Manx – all proposed to be accounted for by reordering of the same set of constraints – is touted as providing evidence for a number of constraints as well as for the existence of the colon constituent of the prosodic hierarchy.

In a similar vein, Bennett (2012) uses Irish PLP patterns as evidence for universal reference to foot structure by comparing varieties with more strictly initial PLP with the 'Munster' system (pp.194-256). Varietal differences in PLP treatment are attributed to differential ordering of OT constraints surrounding weight and foot structure. The exceptional status of /ax/ is suggested to be linked to /x/'s bearing of a mora (unlike other coda consonants), further dependent on the sequence's acting as a quasi-diphthong between an /a/ vowel and a consonant (/x/) roughly homorganic with the low back vowel configuration (pp.216-220).

Following with another OT approach to Munster PLP, Iosad (2013) examines PLP in the Corca Dhuibhne variety of Kerry Irish, based mainly on descriptions by Ó Sé (2000) in his survey of the variety. There is, at the very least, a clear acknowledgement of his reliance on written, impressionistic accounts of PLP location, and of the possibility of non-initial PLP as "epiphenomenal", deriving from timing of high pitch relative to prominent syllables. The account at which he arrives relies on a formal distinction between the concept of 'headedness' in prosodic structures and the location of PLP, the latter of which is claimed to not necessarily require association with a prosodic head. By way of generalising the implications of his analysis, Iosad advances that "the analysis and derivation of Corca Dhuibhne Irish requires the learner to recover a significant amount of what is essentially phonetically vacuous structure, including the notions of recursive constituents, the *X'* schema, and elaborate constituent structure[8]." This is taken as evidence of an ornate abstract phonological structure to which language users have innate access when constructing a grammar for their first language based on ambient input.

A more directly phonetically informed approach to a theoretical account of non-initial PLP in Munster is found in the work of Windsor and colleagues. A chapter of Windsor's (2017) PhD is dedicated to "Syntactically informed phonology in Irish" (pp.27-70), in which he analyses recordings of one speaker each from the Cork and Waterford Gaeltachtaí (in comparison with two further participants from Co. Galway). PLP location was marked in transcription according to the judgements of "phonetically trained undergraduate research assistants", after which potential phonetic exponents of prominence (intensity, vowel duration, and pitch minimum/maximum/range) were measured for the 'stressed' syllable and the syllable immediately following. Results of a statistical analysis using generalised linear models indicated that for both the Connemara and Munster Irish data, increased intensity range was consistently related to the prediction of a syllable's marked PLP status, but that the other predictors with which intensity interacted to yield significant predictive utility varied between the two regions; the Connemara data required an interaction with maximum pitch, while the Munster data required a joint interaction with maximum pitch and maximum intensity. A pitch-accented syllable in the data, meanwhile, is predicted in the Munster data by an interaction between minimum and mean pitch, versus by pitch mean and range in the Connemara data.

Windsor draws together his results on PLP and pitch-accent predictors in the two varieties to suggest that non-initial PLP in Munster derived from alignment of phrase-level pitch-prominence, and historical requirements in the dialect regarding repulsion of prominence from the left edge and overcrowding of phonological tonal targets on single syllables (p.64). This is linked to Munster Irish being a variety with 'top-down' prominence-assignment, according to Gordon's (2014) typology: prominence at the lexical ('stress' in Windsor's usage) and phrasal ('accent') levels are assigned separately, and with reference to different levels of the prosodic hierarchy. A reanalysis at some stage in the Munster varieties' history is suggested to have bifurcated prominence marking at the two levels, and the subsequent existence of two separate pitch-based cues on the originally PLP syllable was repaired by rightward movement of some of those features, itself then reanalysed as non-initial PLP (p.69). This is proposed as an empirically grounded analogue to Blankenhorn's (1981) theory of misalignment between high pitch and PLP. These findings and suggested account are recapitulated in a 2018 paper with colleagues (Windsor, Coward & Flynn 2018).

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[8]Concepts from formal generative syntax and phonology not relevant for this work. Refer to Iosad (2013) and reference texts in generative phonology such as Kenstowicz (1994) for further details.

Blum (2018) provides an exploratory analysis of prominence data from a single speaker of Kerry Irish, in which traditional descriptions of PLP location are compared with positional changes in intensity, pitch, duration, spectral tilt, and vowel F1 and F2. Blum's conclusion is that her informant (and she is careful to stipulate that this may indeed be an individual-speaker phenomenon) has a system of initial PLP with the exception of light-/ax/ items.

Finally, Kukhto (2019) uses data from four speakers of Corca Dhuibhne Irish to examine durational and qualitative reduction of the initial syllable in words of the structure light-heavy-/ax/, with a particular interest in the influence of the medial syllable's vowel. He concludes that non-initial PLP in Corca Dhuibhne is tied to phonological reduction of initial syllables, making them defective for the purposes of PLP-bearing (similar to Iosad 2013). On the back of this, and in contrast with Blum's findings, it is argued that /ax/ does not have a synchronically productive exceptional weight status. The issue of /ax/, its weight status, and its relationship to non-initial PLP is subsumed by RQ2, addressed in Chapters 5-6.

To summarise, the issue of non-initial PLP in Munster (and more broadly in southern Irish varieties) has attracted a considerable amount of attention in the formal phonological literature as having potential relevance for general theoretical debates around possible PLP systems, foot/metrical structure, segmental exceptions in weight-reckoning, the prosodic hierarchy, and the relationship between lexical and phrasal prominence. These matters are interesting in their own right, but it is not my intention in this thesis to address them directly. Rather, my interest is in the fact that the majority of such work has been based on the impressionistic descriptions of PLP location recorded in early-20th-century dialect descriptions and treated collectively by scholars such as Ó Sé (1989; 2000). Those studies (e.g. Windsor 2017 and Kukhto 2019) which have included collection of data with instrumental phonetic analysis represent a more grounded approach, and indeed express some scepticism of received accounts of PLP in the region (e.g. around the genuinely exceptional status of /ax/). However, they continue to rely on stipulated PLP location on the basis of lexicographical and/or dialectological prescription as a starting point from which to consider the correlates of PLP (and reductional correlates of a lack thereof).

As is outlined in Chapter 5 below, in my exploration of archival data from 1928 containing speakers contemporary to both foundational dialect descriptions and – by time-depth, with birth years stretching back to 1846 – to earlier grammatical works such as O'Donovan (1845), I became sceptical of the watertightness of non-initial PLP in Munster Irish. Cases of either highly ambiguous prominences (e.g. mismatched intensity and pitch prominence) would not surprise those authors who specify the abundance of competition between PLP structure in the region, but is not well handled by the formal accounts of the 1990s onwards which report the input 'data' or 'facts' as essentially authoritative as regards definite non-initial PLP. My aim thus became to investigate phonetic exponents of prominence as a function of syllable position and structure, independent of assumptions around 'actual' PLP location, and in Chapter 6 to examine the productive implementation of prominence pattern(s) in the absence of lexical/etymological knowledge using nonwords.

For present purposes, and to conclude this lengthy framing of lexical prominence in Munster, it shall suffice to say that the majority of modern Irish varieties have a general system of initial PLP inherited from Old and Middle Irish. A number of broadly southern varieties, with core representation in Munster, are traditionally described as having developed a system in which PLP occurs on a non-initial syllable containing a long vowel, diphthong, or /ax/ within the first three syllables of a word.

3.3.2 Intonation

The earliest treatment of intonation per se (rather than broad descriptions of 'accent', such as that of O'Donovan 1845) in Irish is that found in the dialect monographs of the early 20th century, a few of which provided 'representative' sketches of phrase-level pitch patterns in the regions in question. Broadly speaking, there is a north/south split in intonational character, with the varieties of Donegal and parts of Sligo and Mayo broadly favouring rising accents. This was noted in passing for the (Donegal) Irish of Tory Island by Quiggin (1906), and broadly confirmed in Dalton's (2008) and Dorn's (2014) PhDs using Autosegmental-Metrical (AM) approaches to regional intonation systems.

Southern varieties, by contrast, default to falling accents, although rises are still attested. By far the most attention has been given to Connemara in this southern group, beginning with de Bhaldraithe (1945) and continued by Blankenhorn (1982) and Bondaruk (2004). Given its immediate relevance for the present work, I will hereafter focus on preceding work on Munster intonation. Contour-shapes (or 'tunes') in Munster and their alignment with text were first described in a British School sketch by Ó Cuív (1944: 71-79) for the Múscraí variety of west Cork, in which he notes a preference for falling 'tunes' over the course of declarative sentences, which may take the form of either a string of high-pitched syllables concluding with a final fall (Figure 10a), or else a series of rise-falls in which PLP aligns with the beginning of the rise. In absolute final position, a rise may obtain. An example of each of these declarative patterns has been extracted and presented below for illustration. It is the second of these (Figure 10b) which Blankenhorn (1981) linked to a possible pitch-derived reanalysis of PLP location at some stage of Munster varieties' historical development.

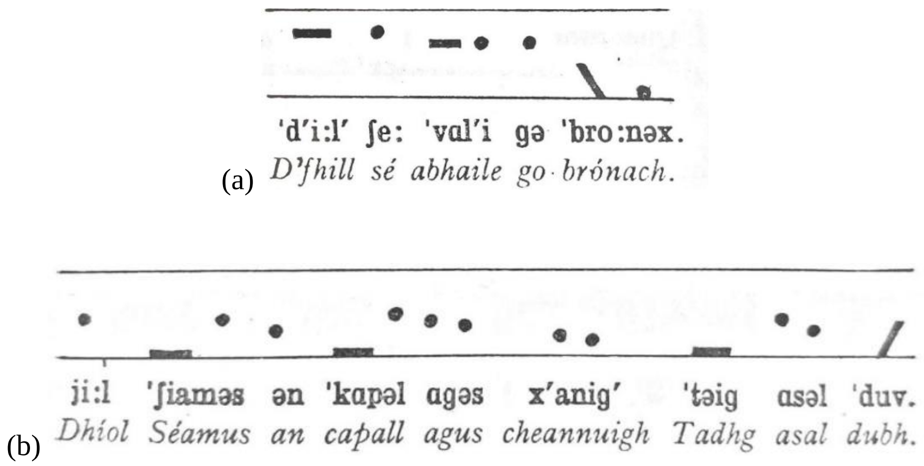

Figure 10 *British School sketches of two declarative 'tunes' from Ó Cuív (1944:75), showing a sustained phrasal high with a final fall (a), and a series of rise-falls in which PLP syllables are low with high peaks on the following syllables (b). Note that metrical prominence (< ' >) is noted phrasally rather than lexically – initial PLP in* cheannuigh *'bought' and* asal *'donkey' is left unmarked. This highlights the phrase-level analysis in question.*

Breatnach (1947: 89-91) provides a more limited sketch of British School 'tunes' for Waterford Irish in his description of the variety of An Rinn. The situation appears broadly similar to that described by Ó Cuív for Cork, although there is no mention of the above 'bouncing' pattern in Figure 10b; rather, a generally tendency towards cross-phrasal falls and runs of sustained high tone are given as characteristic of the variety. Little to no pre-AM description of intonation exists for Kerry Irish, to my knowledge. This asymmetry in investigation of Munster subregions was reversed in Dalton's (2008) AM approach to Irish intonation, the only Munster region included in which was Kerry. Dalton's multiregional survey was followed up by Dorn (2014) and O'Reilly (2014) for details of Donegal and Connacht subvarieties.

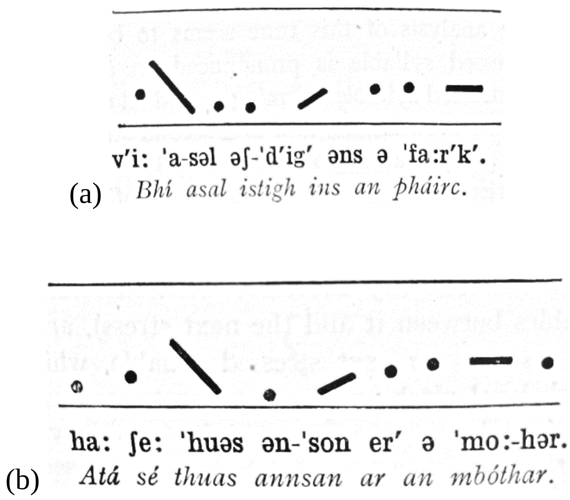

Figure 11 *British School sketches of declarative 'tunes' from Breatnach (1947: 89), showing two versions of a fall (aligned to roughly the second [a] and third [b] syllables of the phrase) followed by a rise-to-plateau until the end of the phrase.*

Two acknowledgements must be made at this juncture. First, invoking mismatches between metrical strength and high pitch, such as that in Figure 10b, as sufficient phonetic ambiguity in prominence-marking to trigger a reanalysis of PLP location raises questions about the relative perceptual salience of low versus high F0. In its simplest form, Blankenhorn's (1981) hypothesis relies on high pitch being a more intuitive mark of prominence than low pitch. Things are not so simple; listeners integrate information on pitch movement and scaling, voice quality, intensity, and duration in their perception of speakers' articulatory effort (Vaissière 2011; Yanushevskaya *et al.* 2016). While it is possible that high F0 peaks have more perceptual salience than low F0 valleys (Jeon & Heinrich 2022), low F0 systematically marking metrically strong syllables is also attested. The rising L*+H accents characteristic of Donegal Irish and northern Irish English varieties are an apt example of the latter. Second, and related, Ó Cuív and Breatnach's descriptions are British School, not AM; in IViE usage, 'tunes' such as that of Figure 10b could be argued to represent either a series of L*+Hs or late-aligned H*+Ls with a final high boundary tone H%.

In approaching the relationship of change in F0, and high pitch regions in particular, with PLP location in Munster (RQ3), it is not my intention to support or promote an exclusive link between perceptual salience and heightened F0. Rather, the F0-concerned portions of Chapters 5-6 and the phrase-level intonational investigation of Chapter 7 approach the hypothesis of right-shifted PLP deriving from reanalysed post-PLP high F0 from a simple timing perspective. The proper phonological representation of any observed delays between metrically strong syllables and heightened F0 as, e.g., L*+H or late-aligned H*+L is left an open question for future work. Insofar as the analyses illustrated in Figures 10-11 can be considered pre-AM, the intonational element of the present work may be best considered AM-adjacent.

Turning then to existing AM work on Irish intonation, in her PhD thesis on the intonation of five Irish varieties (Gaoth Dobhair in Donegal, Cois Fharraige and Inis Oírr in Galway, Iorras in Mayo, and Baile an Fheirtéaraigh in Kerry), Dalton (2008) examined (i) the distribution of different IViE pitch-accent types, and (ii) their temporal alignment with syllabic and segmental material across and within varieties. Consistent with expectations, she found a strong preponderance of rising (L*+H) contours in the Donegal data, in contrast to a preference for falls (H*+L) in all other, more southerly varieties (pp.244-245).

To focus for present purposes on the Munster variety represented in Dalton's sample, nuclear accents (i.e. the last in a given intonational phrase) were exclusively falling, while in prenuclear position there were a substantial minority of rising (L*+H) and monotonal high (H*) accents (the latter presumed to be contextually truncated versions of H*+L, following Gussenhoven 1984). The summary distribution of these has been extracted and provided in Figure 12 for reference.

Prenuclear falls versus rises were classified on the basis of the latter's definition by a pronounced dip in the automatic F0 track associated with the identified metrically strong syllable (i.e. a PLP syllable receiving phrasal intonational prominence). Contrasting examples of labelled H*+L and L*+H in Dalton's Kerry data have been extracted and provided in Figure 13.

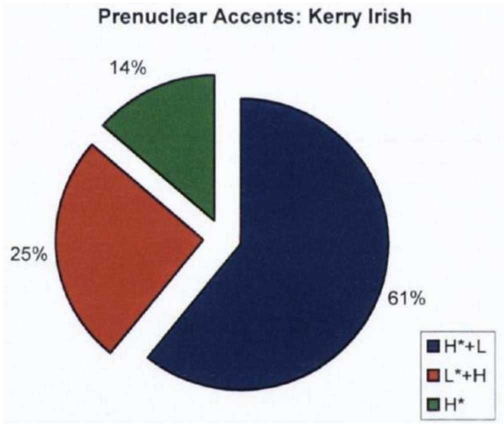

Figure 12 *Distribution of prenuclear pitch accents in Kerry Irish from Dalton (2008: 193)*

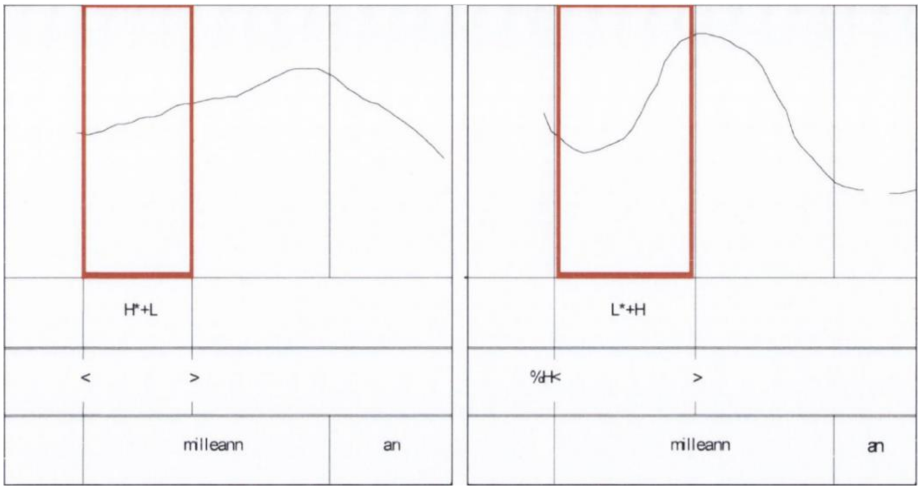

Figure 13 *Contrasting H*+L and L*+H pitch accents in Kerry Irish from Dalton (2008: 199)*

With regards to timing of high (H) peaks with syllabic material, a split is identified between those varieties with relatively stable, fixed alignment of peaks – consistent across positions and variable conditions of pre- and post-tonic syllable counts – and those with notably variable alignment. Into the former category fell Donegal and Cois Fharraige, while Iorras, Inis Oírr, and Baile an Fheirtéaraigh fell under the latter, variable-alignment heading (pp.248-249). For Kerry in particular, this only obtained in prenuclear position, with nuclear falls showing straightforward and consistent alignment between the relevant PLP syllable and a defining H peak. Both the variably late-aligned H*+L and L*+H runs described for prenuclear position in Kerry are reminiscent of the pattern sketched for Múscraí by Ó Cuív (1944) presented above in Figure 10b. It was expected from the outset to observe such patterns in the intonation data collected for Chapter 7, minimally for Kerry and possibly for the other Munster subregions being studied, and it was hypothesised that there would be frequent temporal mismatches between metrically strong syllables and regions of high pitch.

Intonation in Cork has remained more or less untouched since Ó Cuív (1944), but that of the Waterford Gaeltacht (a.k.a *Gaeltacht na nDéise*) was subjected to preliminary evaluation in my 2018 MPhil thesis, broadly following the methods of Dalton (2008) and using the same elicitation materials. In this, a general preference for falling (H*+L) accents in line with Dalton's findings for Kerry was found, with an increase in rising (L*+H) nuclear contours associated with younger and less traditional informants (p.46). Temporal coordination of high peaks with text was broadly fixed to the relevant PLP syllable, but alignment of said peaks with subsyllabic constituents was found to be highly variable across different quantity (syllable-count) conditions of pre- and post-tonic material (pp.62-64).

In summary, Irish varieties are typically described as showing a north-south split in terms of intonation; Donegal and some Sligo border-varieties show a preference for rising contours (L*+H under an AM system), while the remaining varieties of Connacht and Munster appear to default to falling (H*+L) and high (H*) accents, with particular positional and sentence-mode distributions varying by subdialect. A further division has been suggested between varieties with fairly fixed alignment between high-pitch peaks and the PLP syllables to which they are affiliated and those which exhibit movement of peak location based on surrounding syllabic prosodic context.

For Munster in particular, there are at least two descriptions of high pitch not necessarily aligning with lexical prominence, both with emphasis on prenuclear position: Ó Cuív's (1944) declarative 'tune' for Múscraí, Co. Cork, with low pitch on a PLP syllable followed by a rise to high pitch which falls again for the pattern to repeat on the next pitch-accented PLP syllable, and Dalton's (2008) runs of prenuclear L*+H and late-aligned H*+L (with the H at times occurring as late as the syllable following PLP). Limited work on Waterford Irish (Breatnach 1947; McCabe 2018, 2019) suggests a preference for prenuclear falls and/or highs and nuclear falls, with growing evidence of nuclear rises in younger speakers. Available data for this variety indicate reasonably close coordination between PLP and high pitch, possibly subject to variability in subsyllabic alignment relative to segmental landmarks.

3.4 Morphosyntax

Like the other Celtic languages, Irish has default Verb-Subject-Object (VSO) word order. This word order is supplemented by frequent use of 'cleft' sentences in which a constituent is given syntactic focus by means of an initial copular construct followed by a relative clause. For example, compare simple VSO *Tá an fear ag teacht* 'The man is coming' (lit. 'Is the man at coming') with clefted *Is é an fear atá ag teacht* 'It is the man that is coming.' Prepositions in Irish are inflected for person and number, e.g. *liom/leat/leis/léi(thi)/linn/libh/leo* 'with me/you.SG/him/her/us/ you.PL/them'. Both pronouns and prepositions have simple and emphatic forms (e.g. *mé – mise* for plain and emphasised 'I/me', respectively), while nouns under possession can be emphasised by the addition of the suffix *-sa*/*-se*, e.g. *mo bhád-sa* 'MY boat'.

Regarding nominal morphology, Irish possesses a binary system of grammatical gender (masculine/feminine), which derives from a historical ternary system (including a neuter gender, as in German or Latin) which had collapsed by the Middle Irish period (Breatnach 1994). The case system of Old and Middle Irish has collapsed into a two-way system opposing nominal/oblique and genitive cases, with limited exceptions in which a distinct dative form has been retained (Ó Dochartaigh 1992; Breathnach 1994). The latter is evident in words like *Éire* 'Ireland' which has genitive *Éireann* 'of Ireland' and dative *Éirinn* (e.g. *in Éirinn* 'in Ireland) – a further example of contrastive use of the broad/slender consonantal opposition. Datives have also been retained in the plural form by some Munster varieties (O'Rahilly 1932: 215; Ua Súilleabháin 1994). For example, dative plurals *fearaibh* and *mnáibh* may be heard in modern Waterford instead of *fir* and *mná* for 'men' and 'women', respectively; in the 1928 archival data described in Chapters 5 and 7, this generalised dative plural frequently emerged in the word for 'servants' – *seirbhíseachaibh* rather than 'standard' *seirbhísigh* (singular *seirbhíseach*).

3.4.1 Mutation

Grammatical information is further signalled by two processes of *initial mutation* (IM) – *séimhiú* 'softening' or *lenition* and *urú* 'darkening, overshadowing' or *eclipsis*. Initial mutation is a typologically rare phenomenon in which the left periphery of a lexical item is altered for morphological purposes, and which (following Iosad 2010) can be divided into four distinct types, any combination of which may coexist in a given language. These are: (i) mutation lexically conditioned by an immediately preceding item, (ii) mutation conditioned by mutual interdependence between the preceding and mutated items, (iii) general morphosyntactic mutation, which may occur in the absence of linear adjacency or the obvious presence of a conditioning 'mutator', and (iv) mutation which is purely phonological (i.e. not used for any morphosyntactic purpose) but which lacks any obvious phonetic conditioning. Modern Irish exhibits three of these four types of mutation – all but (iv).

This unusual feature, unique amongst Indo-European languages (and non-Indo-European languages of Europe), typifies the Celtic languages. Similar cases are attested in a number of unrelated language families around the world, including West Atlantic in western Africa (including Fula), Uto-Aztecan in Central America, and Nivkh (an eastern Russian language isolate; Iosad 2010). The Celtic cases are perhaps the most well-known and often-cited examples of mutation (Fife 2009). Limited evidence from stele[9] and other scant attestations suggest that the long-extinct Continental Celtic languages (e.g. Gaulish and Ibero-Celtic) did not exhibit mutation, which apparently developed only in Insular Celtic. This arose from the morphologisation of phonetically natural *sandhi* processes operating across word boundaries (Thurneysen 1946: 140), at least some of which became phonologised as discrete (but still phonologically conditioned) alternations. There is a certain degree of controversy surrounding the historical relationship between the Goidelic and Brythonic mutation systems, but this is beyond the scope of the present work.

In Irish, the transition from the phonological (i.e. transparently conditioned *sandhi*) to the morphological was complete by the 6th century BC (Fife 2009), although some estimates suggest a later date for the total disappearance of phonological conditioning (Koch 1995). Details of its development aside, Old Irish possessed three mutations, similar to the ternary situation in Modern Welsh: lenition/aspiration, nasalisation, and gemination. Lenition, derived from a historically preceding vowel, "[reduced] the energy employed in…articulation" (Thurneysen 1946: 74), with fricativisation of stops and deletion or voicing alteration of fricatives (Thurneysen 1946: 76-80). Nasalisation straightforwardly turned initial consonants into their homorganic nasal counterpart as a result of an original preceding nasal (Thurneysen 1946: 147-148). Gemination, in decline by the Old Irish period, lengthened consonant duration under certain declensional and phrasal circumstances (Thurneysen 1946: 150).

By Middle Irish, a dual mutation system derived from lenition/aspiration and nasalisation had more or less stabilised, although the orthographic representation of mutated consonants was variable until the 12th century (Breathnach 1994). This is the system of *séimhiú*/lenition and *urú*/eclipsis inherited by Modern Irish. However, substantial phonological changes since this period, alongside increased isolation of different Irish-speaking populations from one another after the establishment and eventual predominance of English on the island, has further obscured the workings of both mutations.

[9]Stone-carved monuments used to mark boundaries and graves.

Lenition applies to /fˠ fʲ sˠ ʃ pˠ pʲ tˠ tʲ kˠ kʲ bˠ bʲ dˠ dʲ gˠ gʲ mˠ mʲ/, yielding debuccalisation of fricatives and spirantisation or (semi)vocalisation of stops to yield /fˠ~ʲ → ∅/, /sˠ, ʃ, tˠ~ʲ → h/, /pˠ~ʲ → fˠ~ʲ/, /kˠ → x/, /kʲ → ç/, /bˠ mˠ dˠ → vˠ~w/, /bʲ mʲ → vʲ/, /gˠ → ɣ/, /gʲ dʲ → j/. Choice of variant, where relevant, is determined by context, variety, and potentially by individual speaker. Historically, alveolar stops spirantised to /θ ð/ (fossilised orthographically as <th> and <dh>), but loss of interdental fricatives in Middle Irish eliminated this (Breatnach 1994). *Eclipsis* applies to /pˠ pʲ tˠ tʲ kˠ kʲ bˠ bʲ dˠ dʲ gˠ gʲ fˠ fʲ/, adding voicing to voiceless stops and /f/, and changing voiced stops into homorganic nasals, yielding /bˠ bʲ dˠ dʲ gˠ gʲ mˠ mʲ nˠ nʲ ŋ ɲ vˠ~w vʲ/. Eclipsis additionally prefixes /n-/ to initial vowels. The two mutations are used for nominal and verbal morphology, as well as to indicate certain phrasal relationships. For nouns, mutation is often the only bearer of critical gender and number information, most starkly for the possessive particle *a*. The latter's referent is only signalled by mutation of the possessed item, e.g. *cat* 'cat, *a cat* 'her cat', *a chat* 'his cat', *a gcat* 'their cat'. For verbs, lenition is used to indicate past tense, and eclipsis is triggered by the interrogative particle *an* which itself may be dropped colloquially (e.g. *an bhfuil…?* 'is/are…?', or simply *'bhfuil…?*).

There is a good deal of variation in the implementation of mutation in contemporary Irish, both inter- and intradialectally. In particular, the phrasal 'definite dative' mutation in which a number of prepositions trigger mutation on a lexical item following the definite article (e.g. *ar an X* 'on the X') and the complex definite preposition *sa* 'in the' are well-known variables. The definite dative construct triggers lenition in Ulster Irish, but eclipsis in Munster and Connacht. *Sa* varies in choice of mutation by both region and speaker. In addition to frequent uncertainty amongst native speakers when explicitly asked for their own intuitions or preferences in these grey areas, there is often conflict between local traditional usage and the *Caighdeán Oifigiúil* (the official 'standard' synthesised by the Irish government beginning in the 1940s). Participants in a recent study of Waterford Irish, for example, were divided over their preference for lenition or eclipsis following abovementioned *sa* (McCabe 2018, 2019).

Beyond variation in distribution of the two mutations, speakers are often far less consistent in implementing mutation of any type than prescriptive (or, indeed, descriptive) grammars would indicate. This applies to traditional as well as 'new' speakers (Ó Broin 2014). In a study of definite dative eclipsis in L1 speakers of Connacht Irish, Welby, Ní Chiosáin and Ó Raghallaigh (2016) identified only a single speaker who exhibited "…a pattern approaching that predicted by the traditional grammar, i.e. 100% mutation…", and even this individual produced only 88% of expected mutations. By contrast, two participants produced almost no eclipsis at all in the conditions elicited, with the remaining four producing it in 25-50% of expected contexts. It is worth noting that there is only a very limited informational load borne by the type of mutation studied by these authors. That is, the conveyance of grammatical gender or number of referents does not hinge on the absence, presence, or even *type* of mutation implemented in PREPOSITION + *an* ‘the’ *X*. This is not the case for simpler possessive and adjectival mutations, which are uniform across dialects. To omit dative mutation is at worst prescriptively wrong; to omit possessive mutation is to make impossible disambiguation of the grammatical gender and/or number of either a possessor or a modified noun.

To take a brief detour into the mechanisms of sound, the phonetic preconditions for the development of mutation are fairly straightforward; connected speech processes (assimilation, *sandhi*, etc.) are robustly attested cross-linguistically. The leap from this state of affairs to morphological initial mutation, however, is strikingly uncommon, and must derive from the gradual perceptual reweighting of acoustic cues eventually leading to reanalysis of the state of affairs as a grammatical rather than phonetic/phonological alternation. The factors in making this leap, and the representational phonological and implementational phonetic character of mutation systems once developed are a matter of some interest.

Phoneticians working with mutation systems, particularly in Celtic, have long been interested in whether mutation is categorical – that is, whether mutated consonants are entirely indistinguishable from their unmutated (or ‘radical’) counterparts (cf. Falc’hun 1950 on Breton, Scully 1973 and Ball & Müller 1993 on Welsh, and Welby, Ní Chiosáin & Ó Raghallaigh 2011/2016 on Irish). Welby *et al.*. (2011) identified no durational differences between radical and mutated consonants in eclipsing dative contexts, consistent with findings of ‘total’ mutation in Welsh (Ball and Müller 1995). Later investigation (Welby *et al*. 2016) confirmed the lack of durational distinction, and expanded investigation to subsegmental features. The authors hypothesised that mutated consonants may retain characteristics inherited from their original forms (e.g. <bp> [b^{ɣ}] could conceivably exhibit a degree of vestigial aspiration from original, unmutated <p> which would distinguish it from radical <b>). Results provided statistically significant evidence of greater burst intensity in cases of /g^{ɣ}/ derived from original /k^{ɣ}/ (orthographic <gc>) by mutation than from unmutated instances (orthographic <c>), suggested to be a subphonemic cue to <gc>’s lexical identity, or at the very least a productive trace of the phone’s original character. This is similar to Falc’hun’s (1950) findings for bursts in mutated Breton stops. No perception test was undertaken at the time to determine perceptibility of this distinction. The authors note inconsistency/hesitancy in implementation of eclipsis for this particular context, which is worth bearing in mind when considering the possible ‘compromise’ status of a mutated consonant between its original and target phonemes. The almost ornamental nature of mutation in this context could be a factor in the conclusiveness of its implementation.

Inevitably related to its phonetic realisation is mutation's phonological representation. This is explored in some detail for Breton in Iosad (2014), in which a subdivision of mutations are discussed with regards to morphosyntactic conditioning/triggering and relative phonological opacity. Formal accounts of initial mutation take several forms in the literature. The simplest is the total supplanting of one featural specification with another (Wolf 2007; Iosad 2014), couched in the framework of traditional segmental phonology and geometric feature 'trees'. Related to, but distinct from, this approach is the less categorical affixation of a 'floating' feature specification (e.g. palatalisation or nasalisation) to the left periphery of a word (Smith 2016), more consistent with an Articulatory Phonology approach to speech representation and production, which prefers to refer to constellations of articulatory gestures rather than unified segments. Others have argued that mutation does not involve real-time derivation of a mutated form from a radical. Hannahs (2013), for instance, suggests that "Celtic initial mutation involves associations of consonants represented in the lexicon which relate a specific initial consonant of a radical form to its associated mutation reflexes." These latter approaches align in the treatment of IM as 'allomorphic' and entirely non-phonological (Stewart 2004; Green 2006; Iosad 2014).

Listener perception of mutation remains untouched for Irish, but has been investigated for closely related Scottish Gaelic by Ussishkin and colleagues (2017). In addition to being the only perceptual study of Goidelic initial mutation, Ussishkin *et al*.'s study is also the closest equivalent to a suprasegmental study of mutation. In three related experiments, native speakers of Gaelic were directed to make decisions about the identity of potentially mutated monosyllabic stimuli (i.e. whether it was mutated or radical/unmutated. Their results suggested that Gaelic listeners are unlikely to perceive a phone (e.g./f$^{\gamma}$/) as mutated (e.g. <ph> instead of <f>) unless (i) conditioned to do so by preceding context, and/or (ii) primed to do so by the presentation of forced-choice responses, rather than volunteering free responses for what they have heard.

The search for productive and/or perceptual traces of original radical consonant identity in mutation systems is highly reminiscent of work on incomplete neutralisation. In the classic case of devoicing of Dutch and German final voiced obstruents, there is an apparent neutralisation between, e.g. /-d#/ and /-t#/. Instrumental studies indicate, however, that this neutralisation is incomplete: the devoiced obstruent retains demonstrable evidence of its former voicing, and can be correctly identified by naïve native listeners above chance in perception testing (cf. Warner *et al.*. 2004 for discussion of Dutch final devoicing). Apparent homophony may also be influenced by morphological complexity. This was recently investigated by Seyfarth and colleagues (2018) for English, comparing the duration of final /-z/ in homophonous *frees* and *freeze*. Other studies have examined vowel formant trajectory (Scobbie *et al.* 1999) and /l/-velarisation (Sproat & Fujimura 1993). These support the existence of consistent, subphonemic distinctions between apparently identical sequences of segments which are productively robust, and often statistically perceptible to the naïve listener.

The above leaves open a number of related questions concerning the phonetic implementation and perception of initial mutation, both in Irish and generally. The most basic phonetic question is that of the acoustic character of mutated consonants – the object of investigation for Irish by Welby and colleagues (2011, 2016). This stems from an interest in subtle, but quantifiable disambiguation of apparent homophones (e.g. <bp> and <b>), possibly in line with incomplete neutralisation in syllable codas in other languages. A broader perspective on the phonetic study of mutation would also include the epiphenomenal effects of a mutation system on the phonetic character of a language.

While investigation in this vein can undoubtedly overlap with the search for subphonemic cues to the underlying identity of mutated consonants, it is not restricted to the search for disambiguation strategies. It is conceivable that initial mutation could exert influence on the organisation of utterances without facilitating semantic identification for listeners. In other words, differentiated realisation of mutated targets could be imperceptible, but nevertheless robust. We are left with at least three questions: (i) Are mutated consonants distinct from their unmutated counterparts, and, if so, how?, (ii) If so, do mutated consonants tangibly correspond to their radical counterparts in any way?, (iii) If so, are listeners able to take advantage of this correspondence for disambiguation? The first two of these questions are investigated in the productive rhythm experiment described in Chapter 4 below.

3.5 Chapter summary

This chapter has provided a linguistic overview of the Irish language, with a particular focus where pertinent on the Munster macrovariety. This is by no means exhaustive, but it is rather intended to provide sufficient background information for a reader unfamiliar with the language; topics of particular relevance for the present work (i.e. lexical prominence, intonation, and initial mutation) have been addressed in greater detail than less immediately relevant areas (e.g. word order).

Irish is an endangered language of the Goidelic/Gaelic branch of the Insular Celtic languages, with three major dialect groups in Ulster (primarily Donegal), Connacht, and Munster that exhibit distinct phonology, morphosyntactic preferences, and lexis. In common with the other Celtic languages, it shares the morphosyntactic features of a default VSO word order, inflected prepositions, and a robust system of initial mutation. The latter has been previously investigated for phonetic evidence of incomplete alteration of initial consonants (i.e. traces of a mutated consonant's original identity), but findings generally indicate segmental identity between mutated and radical versions of a given consonant. A suprasegmental, syllable-level approach to mutation-derived homophones based around P-centres is presented in Chapter 4 below.

The segmental phonology of Irish is dominated by a distinction between velarised ('broad') and palatalised ('slender') consonants and a two-way contrast in vowel length. Suprasegmental phonology is perhaps the most salient point of contrast across the macrodialects, with regionally-associated differences in intonation and the location of phonological lexical prominence standing out. Southern varieties, and Munster in particular, has long been described as having PLP occurring in non-initial position in the presence of long vowels or /ax/ in non-initial syllables; the development of this has been variably linked to influence of Norman French, alignment of phrase-level intonation with segments and syllables, and variety-specific cues to lexical vs phrasal prominence.

The 'Munster'-type system of variable PLP location has attracted a good deal of attention in formal phonology, but would-be accounts of prominence assignment in the variety often rely on impressionistic descriptions of PLP location. In Chapter 4, RQ1 concerning the rhythmic behaviour and segmental characteristics of initial syllables under initial mutation (framed in Section 3.4.1) is addressed. Chapters 5 and 6 then present a systematic examination of phonetic prominence measures as a function of syllable position and weight structure in order to address RQ2. This takes an empirical approach to open questions of prominence distribution and PLP assignment introduced in Section 3.3. The plausibility of an intonation-based historical explanation for right-shifted PLP in Munster (Section 3.3.1) is then explored in Chapter 7, which addresses RQ3. The findings in Chapters 4-7 are then related back to a broader perspective of Munster prosody in Chapter 8.

4 METRONOME SYNCHRONISATION EXPERIMENT

Having provided background information on prosody (Chapter 2) and the Irish language (Chapter 3), I now turn to the empirical studies which form the core of this thesis, beginning with the experiment on the relationship between perceptual rhythm and initial mutation (IM). This was the first of the investigations carried out, beginning with a pilot study in mid-2019. The rationale for the experiment's undertaking is outlined in Section 4.1, followed by a brief discussion in Section 4.2 of a pilot study undertaken in 2019. The latter will not be excessively dwelt upon, but results from it had a substantial impact on a shift in focus and practical implementation for the final experiment. Additionally, the advent of the COVID-19 pandemic in Ireland from early 2020 introduced a number of complications which affected not only the running of the experiment itself, but also the reliability of the data collected. Under these circumstances, the reasoning developed before and over the course of the pilot phase is arguably of more relevance than it would have been in the absence of such complications. After the experiment is fully framed and the methods of elicitation explained (Section 4.3), three analyses of the data addressing RQ1 are presented (Section 4.3). This is followed by a general summary in Section 4.4.

Generally speaking, this metronome experiment proved to be impractical and not especially illuminating. From a scientific perspective, however, it seems worthwhile to present such cases for consideration by other researchers.

4.1 Rationale behind the experiment

As outlined in Chapter 1, my overarching interest at the outset of this project was in the exploration of unique and typologically rare structural features of Irish and its prosody. The Munster subvarieties of Irish are prosodically noteworthy for the complex system of phonological lexical prominence attributed to them. The movement of PLP away from initial position has been suggested to relate to initial syllables' 'defectiveness' for the purposes of weight-reckoning (by Iosad 2013, amongst others; see discussion above in Section 3.3.1). This has been invoked to account for rightward movement of PLP in, e.g., heavy-heavy disyllables such as *mórán* /mˠoːɾˠɑːnˠ/ 'much, a lot' – with initial PLP historically and in the varieties of Connacht and Ulster, but final PLP described in Munster – in contrast to the attested possibility of initial PLP in other weight structures (e.g. light-light disyllables). This experiment thus developed from curiosity about the phonetic behaviour of initial syllables in Munster Irish varieties, and how this might relate to PLP and phrasal prosody/intonation in the region.

Initial mutation stands out in Irish as a typologically rare feature which affects initial syllables, and therefore attracted my attention as a potential factor in these syllables' apparently unstable behaviour. Previous work on initial mutation outlined in Section 3.4.1 for Welsh (Ball & Müller 1995), Irish (Welby, Ní Chiosáin & Ó Raghallaigh 2016), and Scottish Gaelic (Ussishkin *et al*. 2017) has examined the possibility of sub-phonemic distinctions in the production of segmentally identical mutation-derived homophones, and further whether such differences (if they exist) support the disambiguation of segmental homophones in perception. To date, production studies have typically returned negative results: with marginal exceptions, mutated consonants appear to be identical to their unmutated counterparts. Similarly, perception of a given consonant as mutated appears to require contextual facilitation (Ussishkin *et al*. 2017).

As a prosodic approach to left-edge morphophonology, Franich's (2017, 2018) study of P-centres (Section 2.2) in the context of Medʉmba prenasalisation – a process which bears a close resemblance to the evolutionary precursor of Celtic-style initial mutation (i.e. connected speech processes morphologised as left-edge segmental changes) – was particularly influential. This presented evidence that segmentally identical homophones, varying only in the derivation status of their prenasalised initial segments, were treated differently by speakers in the context of a metronome-synchronisation experiment. Apparently, as such, P-centres may reflect morphophonological differences in addition to their more obvious direct link to segmental composition of syllable onsets.

For initial mutation, prosodic factors have not to this point been explicitly considered in the literature as a potential avenue for disambiguation of mutation-derived homophones. Given this, and in light of Franich's findings for Medʉmba, P-centre location under initial mutation in Irish emerged as an area of interest for an experimental phonetic approach to Irish morphophonology. This is formulated in RQ1a, which asks whether the P-centres of mutated items (e.g. *bpá* /bˠɑː/ '…pay') align with those of their lexical matches (e.g. *pá* /pˠɑː/ 'pay') or their unmutated homophones (e.g. *bá* /bˠɑː/ 'sympathy'). The pilot study reported in Section 4.2 and the statistical analysis in Section 4.5.3 aimed to address an early precursor to RQ1a by examining timing proxies of P-centre location as a function of onset identity and mutation status.

Related to this is Ryan's (2014) proposal that P-centre location may affect weight reckoning, a phenomenon traditionally attributed to the syllable rhyme. Regardless of the resemblance of mutation-derived items to their lexical or segmental counterparts (or indeed to neither), from a more strictly psychoacoustic perspective, P-centres are expected to have different locations for different onset identities, durations, and levels of structural complexity. If P-centre location affects weight-reckoning, then a language such as Irish presents an interesting possibility, as onsets *within* *a single lexical item* may have up to three very disparate forms (e.g. /dˠ/, /nˠ/ and /ɣ/ for broad/velarised <d>).

The possible link between unstable initial-syllable weight and the suggested defectiveness of the same initial syllables for PLP purposes encouraged a controlled investigation of P-centre location and phonetic weight-markers such as duration. RQ1 encapsulates this by asking whether IM-driven onset variability affects initial syllables' weight; this was explored in the pilot study (Section 4.2) and is addressed more thoroughly by the statistical analyses of onset and vowel duration in Sections 4.5.1 and 4.5.2.

What eventually became the metronome-synchrony experiment on P-centre location across mutation-derived homophone pairs in Munster Irish reported below, then, was pursued on the basis of (i) a general interest in the segmental and suprasegmental phonetics of mutation-derived homophones, (ii) evidence of P-centre sensitivity to morphophonological derivation, (iii) the suggested relationship between P-centre location and weight-reckoning for PLP-assignment purposes, and (iv) the proposed defectiveness of initial syllables in Irish for PLP-related weight-reckoning.

The likelihood of a rhythmic distinction between mutation-derived homophones, or of a robust effect of IM on syllable weight was always considered somewhat remote. Further, it should be acknowledged that all varieties of Irish exhibit IM, in contrast to the PLP shift of interest being largely restricted to the Munster varieties. This narrows the scope for IM's contribution to a shift of PLP to non-initial syllables. However, as I have come to be less convinced of the phonological productivity of weight-based PLP assignment in Munster, the hypothetical role played by initial syllable weight in prominence implementation requires less strength to be of interest. Fluctuation in the substance of initial syllables does not have to yield a categorical loss of all initial prominence(s) for a particular lexical item or class of weight-structures, so long as it is evident enough to plausibly introduce ambiguity into the picture for language learners and/or analysts. If such initial-syllable weight-ambiguity is present in other Irish varieties, a conspiracy of other prosodic factors could conceivably prevent this driving a reanalysis of PLP location.

Although ultimately the data from the main metronome experiment (Section 4.5) were impeded by practical issues, and the results turned out to be largely inconclusive, I stand by the rationale behind the experiment's design and overall implementation. It is conceivable that the nature of the remote elicitation forced by the COVID-19 pandemic, and the complications this introduced, may have obscured patterns that would have emerged under laboratory conditions equivalent to those of the pilot study. This is not easy to demonstrate, and cannot be used as an excuse to make unevidenced claims, but is worth bearing in mind for future work.

4.2 Pilot metronome-synchronisation study

In the initial pilot study, three native speakers of Waterford Irish (all men in their 30s living in Dublin) were recruited using existing contacts from previous research in the region to take part in on-site experimentation in the Phonetics & Speech Laboratory of Trinity College. A metronome-synchronisation paradigm was used, in line with other linguistic studies of the P-centre (see discussion of Šturm & Volín 2016 and Franich 2017, 2018 in Section 2.2). Similar to the hypothesis proposed for RQ1a in Chapter 1, it was hypothesised that mutated consonants would exhibit P-centre location in line with that of their radical form, rather than with that of their unmutated homophone.

4.2.1 Methods and materials

Participants were presented with a 60 beats-per-minute (bpm) metronome beat (MB) via over-ear headphones while stimuli were presented on a computer monitor using Microsoft PowerPoint. They were instructed to read the presented stimulus aloud, and to repeat the same ‘in time’ with the metronome beat until the slide was changed. Approximately ten repetitions of each target were collected, although this varied in practice.

In the interest of casting a wide net for pilot purposes, an extensive list of 28 conditions was prepared, which covered: singleton and cluster (consonant + /l/) onsets, simple possessive mutation, and both definite- and possessive-dative mutations. Only one of the two mutation-types (eclipsis/*urú*) was selected on the basis of its more straightforward progression along a phonological continuum (voiceless → voiced → nasal). Additionally, onset consonants were restricted to bilabials to allow for all three variants to occur in all positions and conditions; for velar /k g ŋ/ the nasal does not occur radically, and for coronal /t d n/ mutation is not always reliable in dative conditions. Onsets were all broad/velarised, with the exception of *meá* /mʲɑː/ ‘scales’ which was selected over *má* /mˠɑː/ ‘plain’ due to the latter’s notable infrequency.

Condition	Stimulus	Translation
Radical /p^{γ}/	*pá*	Pay
Radical /$p^{\gamma}l^{\gamma}$/	*plúir*	Flour
Radical /b^{γ}/	*bá*	sympathy
Radical /$b^{\gamma}l^{\gamma}$/	*bláth*	Flower
Radical /m^{γ}/	*meá*	Scales
No mutation possessive /p^{γ}>p^{γ}/	*a pá*	her pay
Eclipsing possessive /p^{γ}>b^{γ}/	*a bpá*	their pay
Dative eclipsis /p^{γ}>b^{γ}/	*ar an bpá*	on the pay
No mutation possessive dative /p^{γ}>p^{γ}/	*ar a pá*	on her pay
Eclipsing possessive dative /p^{γ}>b^{γ}/	*ar a bpá*	on their pay
No mutation possessive /b^{γ}>b^{γ}/	*a bá*	her sympathy
Eclipsing possessive /b^{γ}>m^{γ}/	*a mbá*	their sympathy
Dative eclipsis /b^{γ}>m^{γ}/	*ar an mbá*	on the sympathy
No mutation possessive dative /b^{γ}>b^{γ}/	*ar a bá*	on her sympathy
Eclipsing possessive dative /p^{γ}>b^{γ}/	*ar a mbá*	on their sympathy
No mutation possessive /$p^{\gamma}l^{\gamma}$>$p^{\gamma}l^{\gamma}$/	*a plúir*	her flour
Eclipsing /$p^{\gamma}l^{\gamma}$>$b^{\gamma}l^{\gamma}$/	*a bplúir*	their flour
Dative eclipsis /$p^{\gamma}l^{\gamma}$>$b^{\gamma}l^{\gamma}$/	*ar an bplúir*	on the flour
No mutation possessive eclipsis /$p^{\gamma}l^{\gamma}$>$p^{\gamma}l^{\gamma}$/	*ar a plúír*	on her flour
Eclipsing possessive dative /$p^{\gamma}l^{\gamma}$>$b^{\gamma}l^{\gamma}$/	*ar a bplúir*	on their flour
No mutation possessive /$b^{\gamma}l^{\gamma}$>$b^{\gamma}l^{\gamma}$/	*a bláth*	her flower
Eclipsing possessive /$b^{\gamma}l^{\gamma}$>$m^{\gamma}l^{\gamma}$/	*a mbláth*	their flower
Dative eclipsis /$b^{\gamma}l^{\gamma}$>$m^{\gamma}l^{\gamma}$/	*ar an mbláth*	on the flower
No mutation possessive dative /$b^{\gamma}l^{\gamma}$>$b^{\gamma}l^{\gamma}$/	*ar a bláth*	on her flower
Eclipsing possessive dative /$b^{\gamma}l^{\gamma}$>$m^{\gamma}l^{\gamma}$/	*ar a mbláth*	on their flower
No mutation possessive /m^{j}>m^{j}/	*a meá*	her/their scales
Dative eclipsis /m^{j}>m^{j}/	*ar an meá*	on the scales
No mutation possessive dative /m^{j}>m^{j}/	*ar a meá*	on her/their scales

Table 1 *Stimuli for pilot study of P-centre location and initial mutation. All target lexical items are monosyllables containing long vowels. Conditions range from radical/unmutated items in isolation to three-word prepositional phrases with and without mutation.*

4.2.2 Analysis

Recordings were annotated in Praat (Version 6.1; Boersma & Weenink 2019). Target items were marked as intervals, with boundaries marked for consonants and vowels. Metronome beats were labelled on a point tier. These were integrated into the recording in Audacity as a separate track to the participants' input via an external microphone. This meant that there was a clear record in the analysed recordings of the MB that participants heard at the time of elicitation – a matter of some complication in the main experiment presented in Section 4.3. Once annotated, target and segmental times and durations were extracted, along with MB times. This allowed for the comparison of MBs' timing relative to segmental material.

Two of the three participants (DB and NÓM) took to the metronome synchronisation without any problem. One (CB), however, divided individual words in polylexical/phrasal conditions across different metronome beats. While still in principle allowing for the measurement of P-centre location via synchronisation, this posed some challenges for annotation and information-extraction. In the first place, identifying the beginning of stop-onsets, particularly voiceless ones, ranges from difficult to impossible in the absence of immediately preceding material. This quickly emerged as a problem for analysis of the radical conditions, but was even more challenging for this third participant as virtually none of his initial-stop conditions were immediately preceded by a vowel.

For the remaining two participants, MB location was measured as a percentage of the total onset duration and then compared across conditions. After comparison with other measures, this was determined to provide some control for onset duration. In comparing timing measures across conditions, only the simplest possessive conditions returned anything remotely promising. The more complex phrases and cluster onsets appear to have overcomplicated control of lexical identity, vowel quality, syllable closure, and individual idiosyncrasies. It was for this reason that the stimuli for the main study were later restricted to such simple possessive conditions.

In the pilot data, admittedly with a very small amount of data (n=16 per condition), it appeared with a remarkable degree of precision that mutated items were being synchronised in line with their lexical matches rather than with their segmental homophones. For example, *a bpá* looked to be treated identically to *a pá* with an earlier P-centre, rather than to its unmutated homophone *a bá* with a later one, as shown in Figure 14 below.

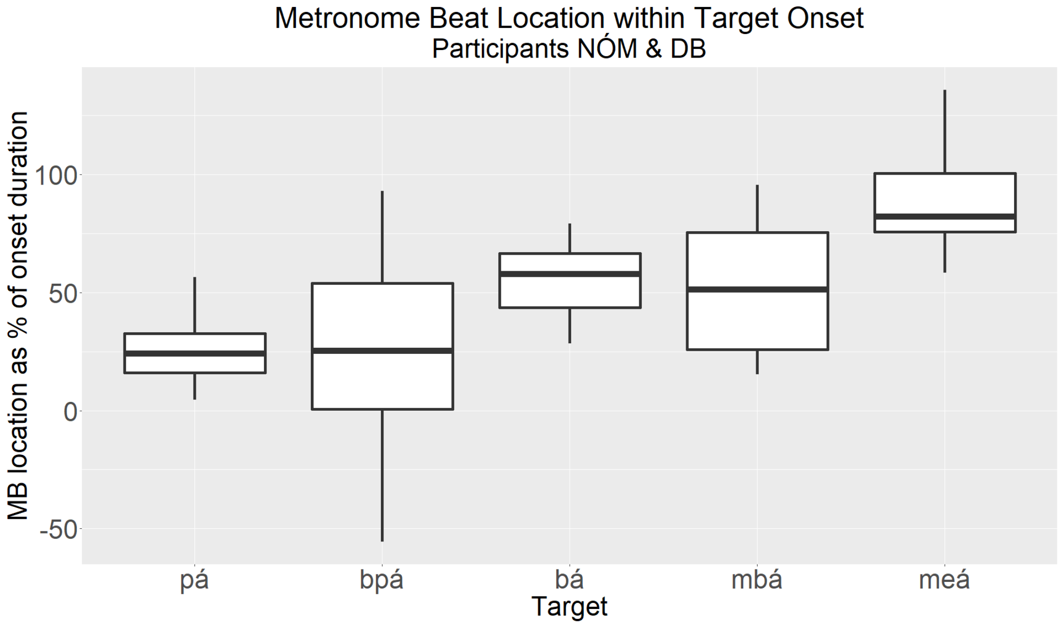

Figure 14 *Apparent P-centre locations across simple possessive conditions in pilot study for participants DB and NÓM. Conditions proceed left-to-right:* a pá *'her pay',* a bpá *'their pay',* a bá *'her sympathy',* a mbá *'their sympathy',* a meá *'her/their scales'. Measured P-centre locations align across lexical pairings (*PÁ *and* BÁ*), distinguishing between mutation-derived homophones* bpá/bá *and* mbá/meá*.*

Insofar as possible with such limited data, these results were statistically evaluated using the non-parametric Mann-Whitney U test, which does not require the assumption of normally distributed data and is adaptable to small numbers of datapoints (McKnight & Najab 2010; Johnson 2013). For this sample size, to reject at significance level p = 0.05 a null hypothesis that two distributions share the same median and are therefore likely to have been selected from the same distribution, the 'U' value must not exceed 75. Pairwise testing of distributions across the mutation conditions using the `wilcox.test`[10] function in R indicated a significant difference between homophones, and no such difference within lexical pairings. This is summarised in Table 2 below.

PAIR	Match Type	U-Value	Z-Score	P-Value	Outcome
a pá – a bpá	Semantic	134 (>75)	0.20729	0.8358 (>0.05)	NO SIG. DISTINCTION
a bpá – a bá	Homophone	75 (= 75)	-1.97867	0.0477 (<0.05)	SIG. DISTINCTION
a bá – a mbá	Semantic	111 (>75)	-0.62187	0.5339 (>0.05)	NO SIG. DISTINCTION
a mbá – a meá	Homophone	68 (<75)	-2.24249	0.0249 (<0.05)	SIG. DISTINCTION

Table 2 *Results of Mann-Whitney U Test for homophone and lexical pairings of P-centre location for 2 of 3 pilot participants, showing significant differences between mutation-derived homophones, and no significant difference between lexical matches*

With this potential effect of morphophonology on metronome synchronisation in mind, although sanguine about the reliability of such a result, I set out to find any segmental durational features

[10]Font used to indicate functions in R. This convention is followed for the remainder of the thesis.

which reflected a similar pattern. Onset durations were consistent within segmental identities, in line with previous findings about the indistinguishability of radical and mutation-derived cases of consonants in Irish and Welsh (Ball & Müller 1995; Welby *et al*. 2016). Vowel durations, on the other hand, appeared to align roughly with the timing disparities: mutated targets *bpá* and *mbá* had shorter vowel durations than their unmutated homophones *bá* and *meá*. This is shown in Figure 15.

Figure 15 *Vowel duration across simple possessive conditions in pilot study for all three participants*

On the basis of these pilot results, a more restricted set of stimuli were developed for main data collection, with the newly hypothesised connection between P-centre location (affected at least in part by morphology) and tautosyllabic vowel duration in mind. A situation approaching that schematised in Figure 16 was envisaged, in which the inclusion of a greater proportion of the syllable onset in the weight-reckoning domain causes earlier P-centres and results in compensatory vowel-shortening.

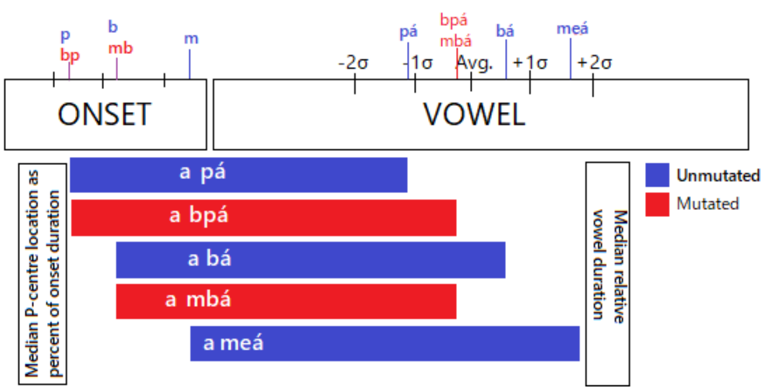

Figure 16 *Conceptual schematisation of the relationship between P-centre location and vowel duration, hypothesised on the basis of pilot study results.*

4.3 Main metronome-synchronisation experiment

Based on the preliminary results of the pilot study presented in Section 4.2, a larger-scale metronome synchronisation experiment was developed. RQ1 was formulated as the guiding questions for the study, namely whether IM-driven variability in P-centre location affected weight in initial syllables, as evident in duration, a common phonetic correlate of phonological weight (RQ1), and particularly whether P-centre location distinguished mutation-derived homophones (RQ1a). For RQ1a, I hypothesised that the P-centre alignment between lexical matches rather than segmental homophones observed in the pilot study would be replicated. For RQ1 more generally, I hypothesised that earlier P-centre locations in any mutation or segmental category would correlate with shortened vowel duration in a given syllable.

4.3.1 Methods and materials

For the main P-centre study, simple possessive targets were the only phrase-type retained from the pilot; stop-initial lexical items in isolation were resistant to analyses reliant on identification of closure-onsets, and more complex phrasal conditions introduced far too much variability for participants. The only alteration made to the original /Cɑː/ stimuli was the replacement of *meá* ‘scales’ with *má* ‘plain, field’ in order to avoid mixing broad and slender consonants; the latter, broad *má* had initially been avoided due to being somewhat uncommon (especially in comparison to the more frequent variant *maigh*).

Additionally, a set of short-vowel/‘light’ syllables equivalent to the long-vowel ‘heavy’ monosyllables from the pilot study was added for consideration. These items had to be disyllabic for reasons of lexical availability (open monosyllables with short vowels are extremely rare in Irish, possibly reflecting a word-minimality requirement or preference; sparse exceptions to this such as *ga* ‘spear, dart’ exist), but were all light-light disyllables with initial PLP and matched segmental and syllable structure with second syllable /kˠə/. There is no radical lexical item /ˈmˠakˠə/ in Irish, and so *mata* /ˈmˠatˠə/ ‘mat, maths’ was substituted, along with its mutated homophone *mbata* (< *bata* ‘stick’). These short-vowel stimuli were introduced to see if any emergent effect of P-centre location and/or morphology on vowel duration applied equally to the two classes of phonological vowel length in the language. The stimuli are laid out in Tables 3-4 below.

	LEXICAL			
SSEGMENTAL		*PÁ* 'PAY'	*BÁ* 'SYMPATHY'	MÁ 'PLAIN'
	/pˠɑː/	*a pá* 'her pay'		
	/bˠɑː/	*a bpá* 'their pay'	*a bá* 'her sympathy'	
	/mˠɑː/		*a mbá* 'their sympathy	*a má* 'her/their plain'

Table 3 *Long-vowel stimuli for main data collection in the metronome study.*

	LEXICAL				
SSEGMENTAL		*PACA* 'PACK'	*BACADH* 'BOTHER'	BATA 'STICK'	MATA 'MAT'
	/ˈpˠakˠə/	*a paca* 'her pack'			
	/ˈbˠakˠə/	*a bpaca* 'their pack'	*a bacadh* 'her bother'		
	/ˈbˠatˠə/			*a bata* 'her stick'	
	/ˈmˠakˠə/		*a mbacadh* 'their bother'		
	/ˈmˠatˠə/			*a mbata* 'their stick'	*a mata* 'her/their mat'

Table 4 *Short-vowel stimuli for main data collection in the metronome study.*

In an initial phase of main data collection, undertaken in the field in the village of An Rinn, County Waterford in February 2020, participants were prompted to produce the presented targets in time with a 60bpm MB, in line with the pilot study methodology. When this was analysed, timing measurements were completely invariant across all conditions, regardless of mutation status or target segmental composition. This gave pause because it failed to show, at the least, the cross-linguistically well-established difference in P-centre location for aspirated stops versus unaspirated stops and nasals. It quickly became clear that in removing radical words in isolation (e.g. *pá* 'pay' in addition to *a pá* 'her pay') as the minimum target, participants were no longer guided to align the metronome beat with the target lexical items rather than with whole target phrases.

As a consequence of this lack of implicit guide in target alignment, all 7 participants recorded at this time – without exception – aligned MBs to the phrasal onset (invariant possessive *a* in all cases). This of course yielded information only about the P-centre of *a*, rather than about the variable targets of interest. To fix this, 'dummy' reference targets were introduced: *tá* for the heavy monosyllables, and *taca* for the light-light disyllables. These were presented alongside the phrasal target of interest, e.g. *tá – a bpá* or *taca – a bpaca*. Participants were instructed to repeat these dummy items in alternation with the actual targets being elicited, in order to replicate the 'guiding' effect of the radical targets included in the pilot study.

Main data collection was carried over Zoom due to the COVID-19 pandemic, which eliminated the possibility of fieldwork precisely when the newly restructured, dummy-inclusive stimuli were in place. This decision was taken after nearly ten months of public health restrictions, with online recording beginning in December 2020; initially it had been unclear whether restrictions would lift in short enough order to justify waiting for a return to in-person fieldwork.

Recruitment of participants was carried out via personal contacts, social media, and the ABAIR project's *Líonra Faisnéiseoirí* (*LíoFa*) ['Network of Participants']. Stimuli were presented on PowerPoint via screensharing. Participants were guided in recording themselves locally, on their own computers, using Audacity. Zoom's automatic microphone-adjustment settings were disabled on both my own and participants' machines. Participants were then directed to send their recording as a .wav file via e-mail, and in case of complication a backup recording was made of the Zoom session itself (the use of which was only necessary for one participant).

A total of 14 participants were recruited, of whom 12 were able to complete the metronome task. The remaining 2 (CO3 and CO4) declined on grounds of stamina, but did participate in the story reading and retelling task used for Chapters 5 and 7. Of these 14 participants, 11 were female and 3 male, with ages ranging from 20-89 (20-76 for the present metronome task). All had grown up with Irish as a household language in a designated Gaeltacht region. Table 5 on the following page provides a list of participants with cursory information on their language background.

Participants were given a basic explanation of the task, and were told that it had to do with *cursaí rithime sa chaint* ('matters of rhythm in speech'). They were explicitly told to alternate between target and reference, assigning one beat for each (to avoid possessive particle and target each receiving a beat, as arose for pilot participant CB, and for some participants during the aborted initial main data collection). Illustrations of the stimuli were laid out using simple graphics, along with the provision that each item would appear in the possessive for the feminine singular (no mutation) and plural (eclipsis). A brief demonstration was also provided using a target (*gá*) not found in the elicitation materials to ensure that participants understood what was expected of them.

A short break was provided after each of three trials of the 12 targets (5 heavy monosyllables, 7 light-light disyllables). Each target was repeated at least 15 times per trial, with the aim of discarding the first 5 tokens of each trial as warmup/entrainment. When it was felt necessary, a given target was left on screen for longer to collect additional 'hazard' tokens (for example, if a mistake was made in the initial repetition(s) of the item in question). 12 speakers participated in total (5 Kerry, 4 Cork, 3 Waterford), each providing 30 usable repetitions after warmup-discard of each of 12 targets for a total of 4320 tokens (30x11x12).

County	Speaker	Born	Mother's L1	Father's L1	Highest education via Irish
Kerry	CI1	2001	Irish	English	Tertiary
	CI2	1997	Irish	Irish	Secondary; Mix at tertiary
	CI3	1964	Irish	Irish	Secondary; Mix at tertiary
	CI4	1993	Irish	English	Secondary
	CI5	1945	Irish	Irish	University
Cork	CO1	1975	English	Irish	Secondary; Mix at tertiary
	CO2	1965	Irish	English	Secondary
	CO3*	1932	Irish	Irish	Secondary
	CO4*	1943	English	Irish	Secondary
	CO5	1971	English	Irish	Secondary
	CO6	1967	English	Irish	Tertiary
Waterford	DE1	1959	English	English	Tertiary
	DE2	1991	Irish	Irish	Tertiary
	DE3	1973	Irish	Irish	Tertiary

Table 5 *Participants in study (* indicating participation in only the story reading/retelling task). A total of 14 L1 speakers of Munster Irish were recruited. This table indicates their Munster subregion (i.e. county), birth year, parents' L1, and the amount of education they received through the medium of Irish at the time of recording.*

Unfortunately, due to technical constraints in Audacity, it was not possible for participants to record while simultaneous playing a metronome beat; this had been possible in Audacity in the original in-person setup, but required the use of an external microphone, which could not be guaranteed for the majority of participants. Instead, the metronome beat was shared over Zoom from my own computer while participants' local Audacity was left to the task of recording. Participants were instructed to use their computer's speakers, rather than headphones, such that the metronome beat playing over Zoom would itself be recorded locally.

It should be acknowledged before proceeding that this is an extraordinarily suboptimal arrangement for a task of this nature, and that this was evident from the outset. As will become clear in the discussion of the data collected and attempts at their analysis, the impact of this on the viability of the metronome synchronisation task was substantial. Most notably impeding to the task were variable connection delays in Zoom, and individual sound-processing settings on participant computers. The latter led to the metronome beat being filtered out as background noise by most microphones; this is addressed below.

4.3.2 Annotation

Annotation of the data was carried out in Praat (Version 6.1; Boersma & Weenink 2021). After labelling of targets, all tokens were marked for: (1) start- and endpoints and duration for relevant ‘base interval’ (distance between reference targets), (2) start- and endpoints and duration for the whole token (including preceding possessive *a*), (3) onset start- and endpoints and duration, (4) vowel start- and endpoints and duration (only for the initial PLP syllable for disyllables). An illustrative annotation can be seen in Figure 17.

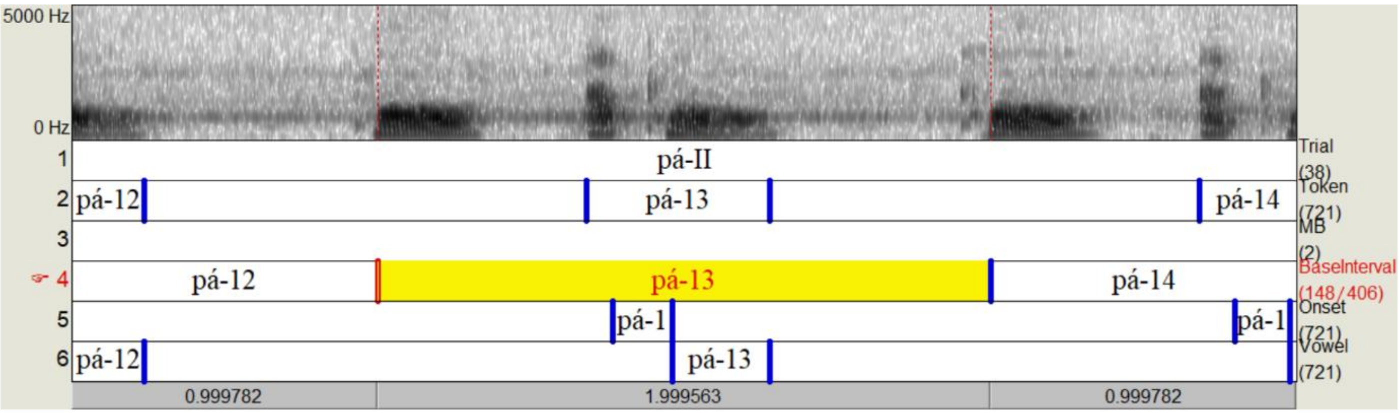

Figure 17 *Example TextGrid annotation showing target identity* (pá)*, trial number* (II) *in Tier I (‘Trial), token number (13) in Tier 2 (‘Token’), the interval between preceding and following dummy* tá *vowel onsets (Tier 4, ‘Base Interval’), the target onset (Tier 5, ‘Onset’), and the target vowel (Tier 6 ‘Vowel’).*

As noted above, MBs could not be reliably identified in the recordings due to variable sound-processing settings across machines. To address this, I had planned to rely on a ‘surrogate’ metronome beat in analysis by calculating 1000ms intervals based on the last visible beat in each spectrogram. Confoundingly, this was itself sabotaged by sporadic and inconsistent delays in transmission over Zoom, highly dependent on individual internet connections and server traffic of the day. Using one of the few recordings in which the over-speaker metronome beat had *not* been filtered out as background noise as a test case, I was able to compare the ‘real’ metronome beats visible in the spectrogram and calculated ‘surrogate’ ones which stipulated a constant distance of 1000ms between each beat, beginning with any immediately pre-task beat that had not yet been filtered out as background noise by a given computer microphone.

As illustrated with reference to the recording of participant CI1 in Figure 15, the assumption of a relatively small margin of error between real and calculated surrogate MBs was flawed. At approximately subtrial 14, there was evidently a brief spike in transmission delay which was resolved by subtrial 19. From there until subtrial 34, the gap between beat-types is consistent but greatly increased, as the calculated surrogate beat is by nature blind to the brief period of unreliable timing and is now inaccurate by a massive 400ms. Another period of instability around subtrial 34 adjusted the size of the gap again. In practical terms, this meant that a calculated metronome beat was not a viable equivalent for what the participant had been hearing during production. With the latter (the MB itself) unavailable in most participants' recordings, the intuitiveness of measuring targets' synchronisation with the metronome beat was severely compromised. Various approaches to overcoming or compensating for this challenge are returned to in discussion of analysis and results in Section 4.4 below.

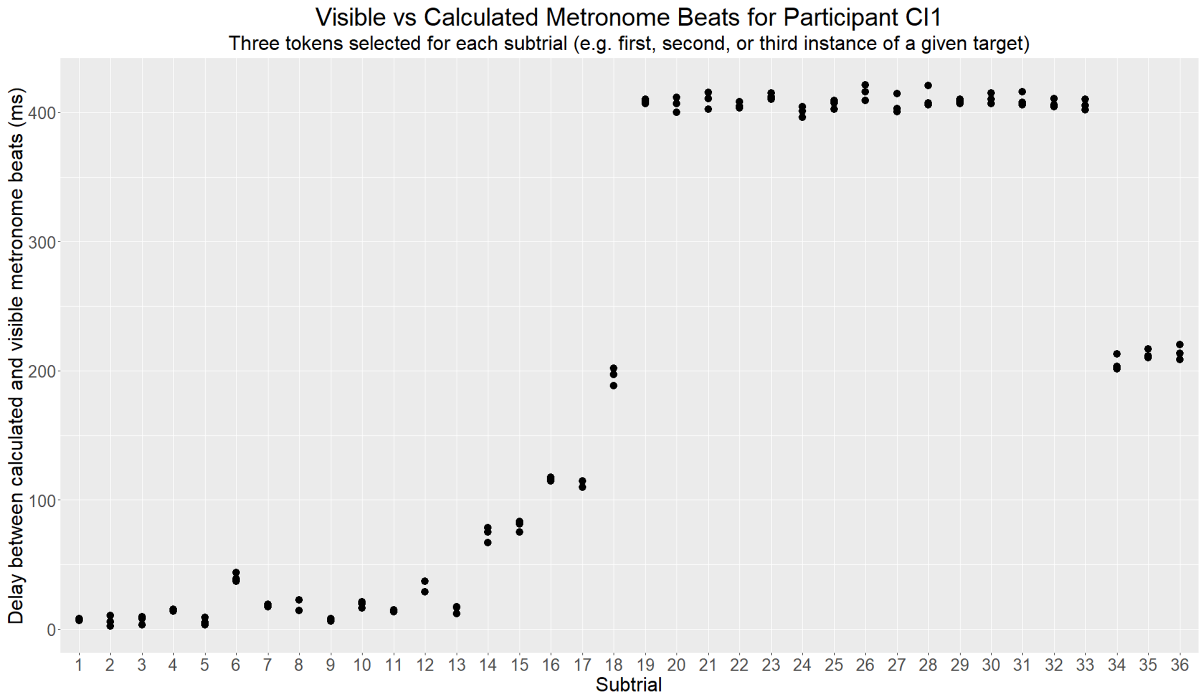

Figure 18 *Illustration of inconsistency between 'real' (recorded) and 'surrogate' (calculated) metronome beat for recording of participant CI1. Discrepancy is minimal until halfway through task, at which point a delay is introduced by connection problems. The delay is then stable until another connection fluctuation towards the end of the task.*

In the absence of a reliable metronome beat visible in the spectrogram for the majority of recordings, (1)-(4) can be used to derive a number of measurements of targets' relative timing. These can be grouped into three broad types based on measure-derivation, all of which rely in some way on the reference *tá*/*taca* dummy targets (herein referred to as the *base* stimuli, and the interval between them in which a given target falls as the *base interval*). Given the latter's constant repetition throughout the task, these are the most straightforward, if indirect, record of the metronome beat to which participants were being exposed.

The first such measure-type comprises attempts to create a 'surrogate' metronome beat, which can then be treated in the same way as the real beat present in the pilot data and initial phase of main data collection (i.e. with its location within onsets and temporal distance from segmental landmarks measured and compared). To this group belongs the original plan to generate pseudo-beats at 1000ms intervals following limited instances of the actual metronome beat at the beginning of recordings. Using the base stimuli and base intervals, one can take as a surrogate metronome beat the base-interval midpoint, the timepoint 1000ms after the preceding base, or the timepoint 1000ms before the *following* base. Arguably, the latter two would be only superficially distinct from using either base as a time reference. This makes for the second measurement type: looking directly at the distance between the base(s) and particular landmarks in the target. The third and final type involves ratios comparing the proportions of the base interval on either side of a given target, either as a whole or with reference to a particular landmark within it.

For an initial comparison, it was decided to carry out one measurement of each type for purposes of comparison before proceeding to modelling of potential relationships holding amongst P-centre location as estimated via said measurements, mutation status, and duration of subsyllabic constituents. Base-interval midpoint as a percentage of onset duration was selected for the surrogate metronome-beat class, distance between preceding base and target vowel onset for the individual-base reference class, and ratio of preceding portion of base interval to the following one with target onset as the dividing point for the ratio class. These were selected on the basis of extensive visualisation and comparison. The most basic threshold for measurement utility was the reflection of a timing difference between onsets /pˠ/ and /bˠ mˠ/. Each of the three measures is schematised in Figures 19-21.

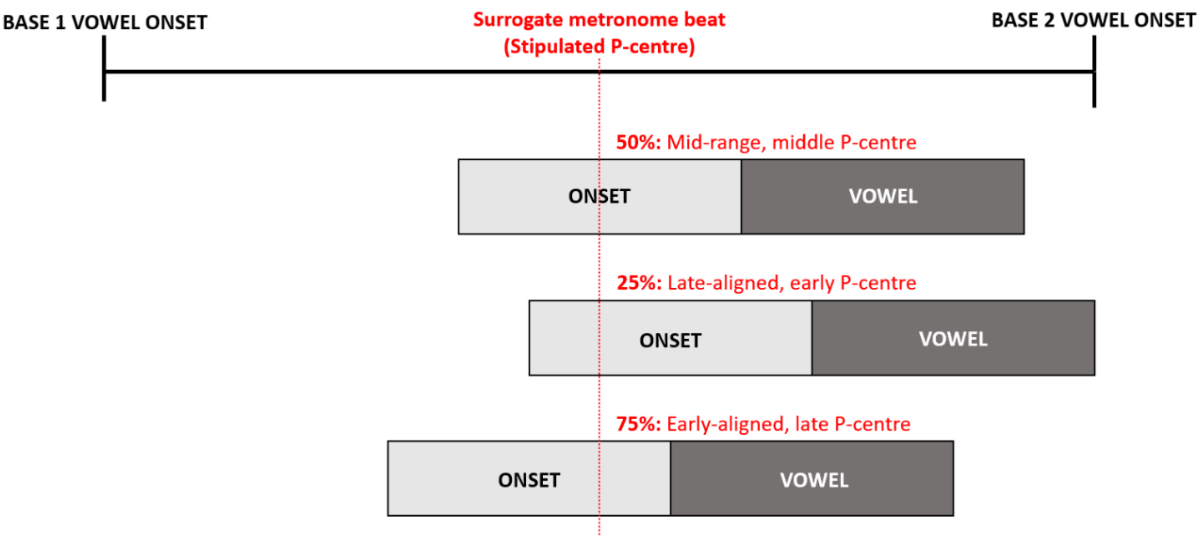

Figure 19 *Conceptual illustration of relative timing measure using base-interval midpoint as a surrogate 'metronome beat'.*

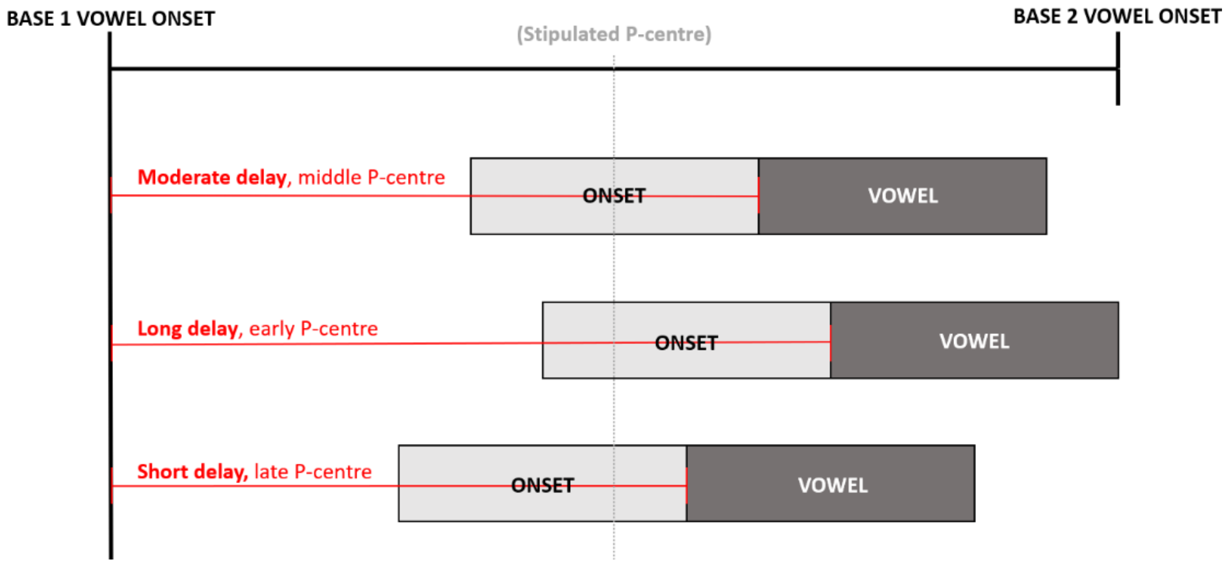

Figure 20 *Conceptual illustration of relative-timing measure using delay between base and target vowel onsets.*

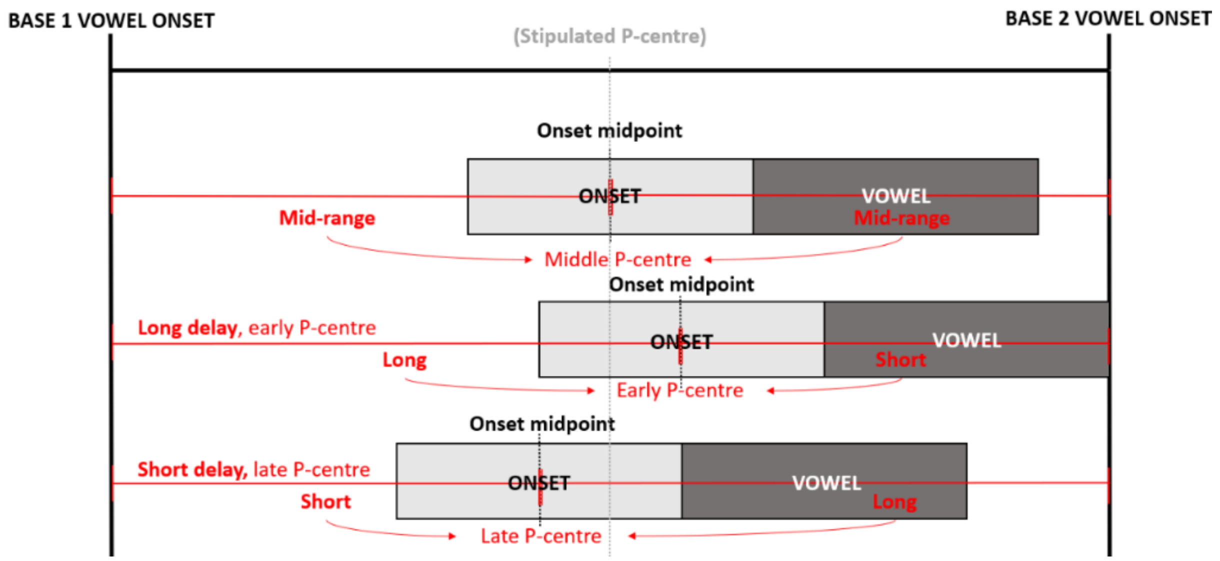

Figure 21 *Conceptual illustration of relative timing measure using a ratio of the duration of the base interval portion preceding the target onset-midpoint to that following the same landmark.*

All outlined measurements are dependent on the duration of the base interval and its relatively consistent realisation, illustrated in Figure 22 below. Most participants appear indeed to have produced a normal base interval approximately of the expected 2000ms (that is, a space of two 60bpm beats), with normal distribution of points and no apparent difference across targets. Two speakers (CI4 and CO6) did remarkably poorly. It was useful to flag this early in the analysis, so that their measurements could be treated as potential outliers, and where necessary be removed from consideration, given how unreliably they fared in this baseline assessment of temporal coordination.

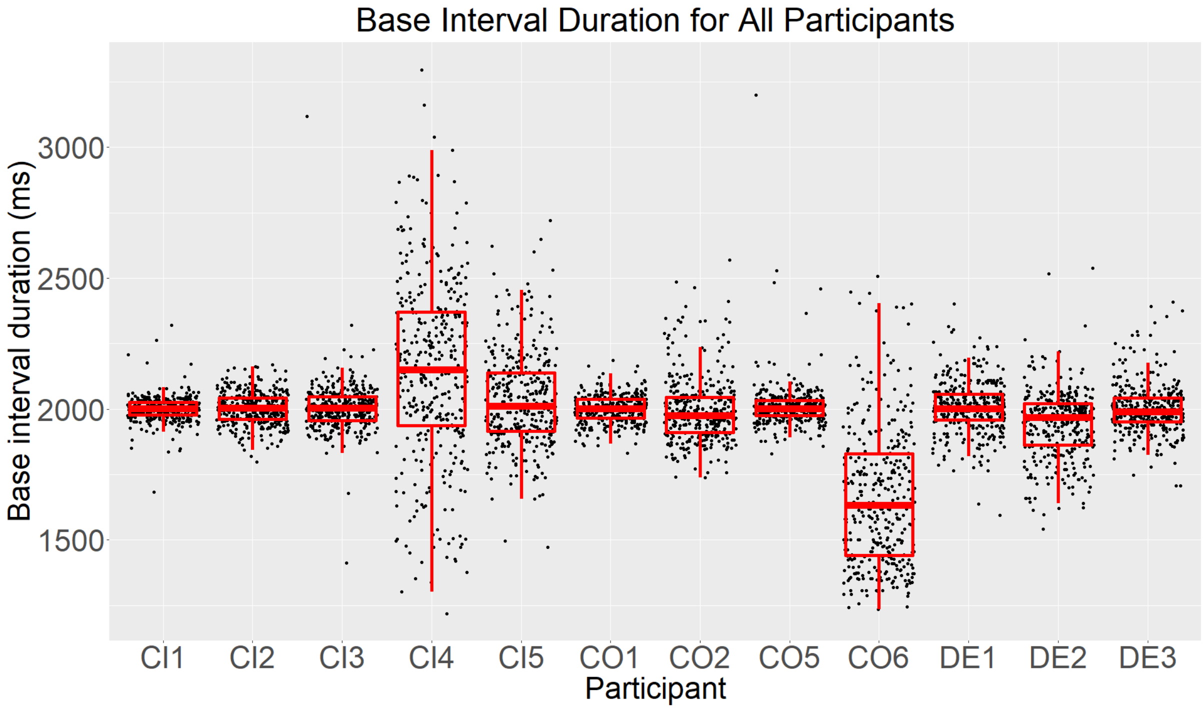

Figure 22 *Duration of base intervals for all speakers, with individual target identities colour-coded.*

Ultimately, the duration between base and target vowel onsets (that schematised above in Figure 20) was selected as the only timing measure for modelling. This was the only measure which successfully distinguished between earlier P-centres for /pˠ/ and later ones for /bˠ mˠ/. Given the already tenuous nature of these data and their investigation, to attempt a statistical approach to the question of the P-centre's sensitivity to lexical identity and/or initial consonant mutation in the absence of even a basic distinction between inherently unmutated /pˠ/ and other potentially ambiguous items was considered futile. The distribution of each of the three timing measures outlined in Figures 19-21 across phoneme and lexical categories is provided in Appendix A. The raw target-to-base measures in milliseconds were z-scored by speaker (speaker-standardised) after confirming that values were normally distributed within each speaker's range.

Additionally, simple measures of token and segmental duration were taken. Both mono- and disyllabic targets (including their associated possessive particle *a*) had total durations between 600-800ms, regardless of speaker or condition. Segmental durations were log-transformed, as is standard practice with positively skewed measures that are inherently greater than zero, including for segmental duration in phonetics (Rosen 2005). This transformation also reflects the reduced impact of small changes at greater durations (e.g. the impact of a 5ms difference on a 10ms vowel versus on a 100ms one). After confirming that these log-transformed durations were normally distributed, they were z-scored by participant (speaker-standardised), with separate treatment of vowels by phonological length categories. This allows for the interpretation of a z-score of 0 for a given vowel as the category-specific norm (i.e. an average long-vowel duration versus an average short-vowel one).

4.3.3 Methods for statistical analysis

All of the statistical analyses carried out in Sections 4.3.4-4.3.6 and in Chapters 5-7 comprise linear mixed-effect models in a Bayesian framework. I decided to take this approach – in what I would stress to be a very elementary and exploratory form (Röttger 2019) – on the basis of greater flexibility in model specification, the advantage of prior distributions being able to compensate for gaps in the data, and more fluid model interpretation in circumstances of what would amount to low statistical power in a frequentist framework. The methodological framing here and in the discussion of the first model in Section 4.3.4 are representative of all subsequent models in this thesis; treatment in later sections and chapters is consequently abbreviated where appropriate.

Statistical analysis was carried out in RStudio using the package `brms` (Bürkner 2016). Bayesian methods and workflows for speech science and linguistic research have been outlined in papers such as Vasishth *et al.* (2018), Schad, Betancourt & Vasishth (2021), and the online workshop *B4SS – Bayesian Analysis for Speech Science* sponsored by the Association for Laboratory Phonology in July 2021, run by Timo Röttger, Joseph Casillas, and Stefano Coretta; these should be assumed as a default reference for the mechanisms and methods outlined below unless otherwise stated. I provide in this section an overview of relevant concepts and practical methodology, however the sources above and works cited therein should be referred to if further details of Bayesian analysis are of interest, as a thorough tutorial on statistical methodology is beyond the scope of this thesis.

A Bayesian approach to statistical modelling begins with a set of *priors* (specified distributions of plausible ranges within which the value of a parameter can fall) and then proceeds via a series of simulations to explore supplied data. It is standard to use so called 'weakly informative' or 'regularising' priors which, while not excessively restricting the model's outcomes, limits the likelihood of extreme parameter values *prima facie*. The two alternatives of 'flat' priors (under which all parameter values are considered equally plausible and likely) and highly specific 'informative' priors can complicate model computation and overshadow the patterns actually observed in the data.

Priors must be supplied for all parts of a model, including the intercept (the estimated value of the dependent variable when all predictors are equal to 0) and slopes (the estimated change in the dependent variable per unit-change in each predictor). Take the z-scored vowel durations described in Section 4.3.2. A Bayesian model with the aim of analysing predictors of vowel duration may start with a weakly informative intercept prior comprising a normal distribution with mean 0 and standard deviation (SD) 1. This is a plausible starting point for the model, in that it restricts the possible range of vowel durations when all predictors are at 0 to within roughly 2 SDs of speaker-average[11]. Similarly, the same distribution could be used as the slope prior. This would allow for a reasonable range of potential effects of a given predictor (e.g. onset duration) on z-scored vowel duration from -2 to +2, with a range of -1 to +1 being considered more probable.

After setting priors, specifying the model parameters, and supplying the input data, the model runs a given number of *iterations* over a specified number of *chains*. An individual iteration can be thought of as a single simulation, akin to rolling a marble in a basin of a particular topography and recording the course of its journey. The goal of the model is to describe the topography of this basin (the data) – with an informational starting point of the priors and the observed data themselves – by accumulating a number of measurements from rolling said 'marble' around the 'topography' of the observed data. It has been my experience that a few marbles may be lost in this process.

The end result of the modelling process is the *joint posterior distribution*: a compromise between the information supplied in the priors and the distribution of the observed data themselves. Said joint posterior distribution summarises the distribution of estimated parameter values (and the likelihood of each value based on its rate of occurrence in simulation) within a credible range – so-called *credible intervals*. The parameters in question are those specified in a given model's formula, such as the intercept, the slope of fixed effects, and the standard deviations associated with random effects. The distribution of values within these intervals correspond to the frequency within which a particular estimate of a parameter (e.g. effect of onset phoneme identity on vowel duration) was recorded in the series of simulations comprising the various chains. It is common to discuss 95% credible intervals, that is the range of estimated values the frequency of which is 95% credible. However, any other credible interval (e.g. 51% – credible at just above chance) can be referenced with corresponding adjustment of certainty in any inferences drawn.

The convergence and performance of a Bayesian model can be assessed via so-called trace plots of the various 'draws' of constituent chains of the model (which can flag divergences in estimation across iterations), via R-hat values (with a value of 1 indicating satisfactory convergence), and by *posterior predictive checks*. The latter compare the model's predictions for the value of the

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[11]95% of datapoints in a normal distribution fall within 2 standard deviations of the mean, while 68% fall within 1 standard deviation (Winters 2016: 55-56).

dependent variable in question for the supplied data (or a subset thereof) with the actual values associated with those same data. Ideally, these two sets of values should be very similar, thereby demonstrating that the model is producing predictions which broadly align with observed data. This approach to statistics does not lend itself to binary decision-making about the presence or absence of an effect in the data. It also does not involve the construction and testing of a null hypothesis and its 'significant' acceptability or rejection as a way of assessing the chance of a model's results being spurious. Rather, it provides a way of assessing relative (un)certainty about effect strength within a given model specification, on the basis of prior knowledge, in light of the observed data. This being the case, there is no significance testing (such as the p-values ubiquitous in frequentist statistics), and while there are methods for mathematically comparing models (using, e.g., Bayes factors), such steps are often not recommended in the early stages of exploring the credible parameter space for a particular field.

Three Bayesian mixed-effect linear regressions, reported in Sections 4.3.4-4.3.6, were carried out to assess the potential relationships among segmental durations, timing as measured by the base-vowel-to-target-vowel measure, and (morpho)phonology. Each model minimally included speaker as a random effect, to allow for variability across individuals in magnitude and directionality of any potential effect (Winter 2016: 234-240). These models in turn address RQ1, first assessing the behaviour of P-centre location in mutation-derived homophones (Section 4.3.4), and then the behaviour of subsyllabic constituents as indicators of initial-syllable weight-stability (Sections 4.3.5-4.3.6).

4.3.4 Statistical predictors of target timing

This first model examines the duration between base and target vowel onsets – i.e. the timing measure selected as the most promising P-centre proxy out of the possible candidates under the circumstances of remote data collection – as a dependent variable. This addresses RQ1a, repeated below from Chapter 1 for ease of reference, along with its associated hypothesis:

> **RQ1a:** In terms of P-centre location, do mutated items align with their unmutated/radical counterparts, or with their segmental matches?
> ***Hypothesis*:** Mutated items align with their lexical matches, rather than with their homophones (e.g. the P-centre of *bpá* matches that of *pá*, not that of *bá*).

If the hypothesis is correct, then it should emerge in the joint posterior distribution of the model that the base-to-target timing measure selected as a P-centre proxy is roughly equivalent between lexical matches (e.g. *pá-bpá* or *bata-mbata*) and distinct between homophones (e.g. *bá-bpá* or

mata-mbata). In the particular model structure, outlined below, this would emerge as the estimated slope of onset phoneme in interaction with mutation being equivalent to the slope estimated for the same onset phoneme without mutation.
This was the least parsimoniously specified of the three models, as, given the amount of variability in the timing measure's apparent reliability in the previous sections, it seemed worthwhile to examine a larger number of factors that could plausibly affect it. The onset phoneme predictor was specified as three contrast-coded dummy variables, i.e. all onsets were coded as +/-P, +/-B, and +/-M. Speaker-standardised log-transformed duration was also included, as were target mutation status (as binary +/-MUTATED), and overall target duration (speaker-standardised). Two additional predictors comprising interactions between mutation status and onset phonemes /bˠ mˠ/ were specified. These estimate change in the timing measure as a function of concurrent change in both phoneme identity (e.g. /pˠ/ to /bˠ/) and mutation status (e.g. - to +). Random slopes were fitted by speaker and target structure/length-category (i.e. monosyllable long-vowel targets versus disyllable short-vowel targets) to allow for potential variation in both size and direction of predictors' effects across these groups.

Weakly informative, normally distributed priors with an average of 0 and a standard deviation of 1 (`set_prior('normal(0,1)')` in `brms` syntax) were supplied to the model for the intercept, slopes, sigma (standard deviation of the residual error), and SDs across levels of each random effect. This was considered appropriate for a z-scored dependent variable, known definitionally to be normally distributed around a mean of 0. Any effect on this variable is in terms of z-units, or SDs in the vowel durations z-scored by speaker.

Regarding slopes, these priors begin the model with the assumption that the effect of a given predictor (onset duration, onset phoneme, mutation status, etc.) on target timing is most likely to be 0 (i.e. no effect), and if non-null then constrained to 2 SDs or less. For example, modelling proceeds on the basis that an increase in 1 SD for a given target's onset duration will not condition a change of more than 2 SD in the same target's vowel duration (whether an increase or a decrease).

Distributions specified for sigma and standard deviation priors are automatically truncated (i.e. a 'half normal' distribution in this case), as a standard deviation cannot be negative. Similar to the population-level prior(s), these half-normal distributions favoured tightly constrained variation across random-effect levels (i.e. standard deviations close to 0 for population-level effects across the various speakers and weight structures), beyond which 95% of credible values for variation are of 2z or less across levels of a given random effect. A higher SD indicates a wider range of variability in a given slope across the levels of the random effect in question (e.g. more variability in model estimates across individual speakers). Finally, the prior for the correlation between variables (`cor()`) was specified as the so-called ‘LKJ(2)’ value (Lewandowski, Kurowicka & Joe 2009), considered to be a standard in the literature (Vasishth *et al.* 2018). Four chains of 2000 iterations, each with the first 1000 iterations discarded as warmup, were used.

A posterior predictive check indicated that model predictions are broadly in line with the attested data. That is, the model generates predictions for onset duration of the original datapoints that more or less resemble the durations observed in the actual data. This holds for all targets and speakers. Results of this and other posterior predictive checks, along with model formulae can be found in Appendix A.

Turning then to the credible intervals of the parameter values under consideration in Figure 23, it does not appear that the predictors considered are robustly useful in determining a given target’s temporal coordination and, by slightly tenuous extension, P-centre location. All parameter slopes have both 95% and 50% credible intervals overlapping with and in most cases roughly centring on 0: it is not remotely justified to rule out a null effect as a credible reality. Most closely approaching a non-null effect (both positive) are onset and token duration, for which there is the very weak possibility of an increase in the base to target vowel-onset delay as onset and/or token duration increase. Although not particularly credible, this is at least in the expected direction for longer onsets, and aspirated /p^{γ}/ in particular, to have an earlier P-centre.

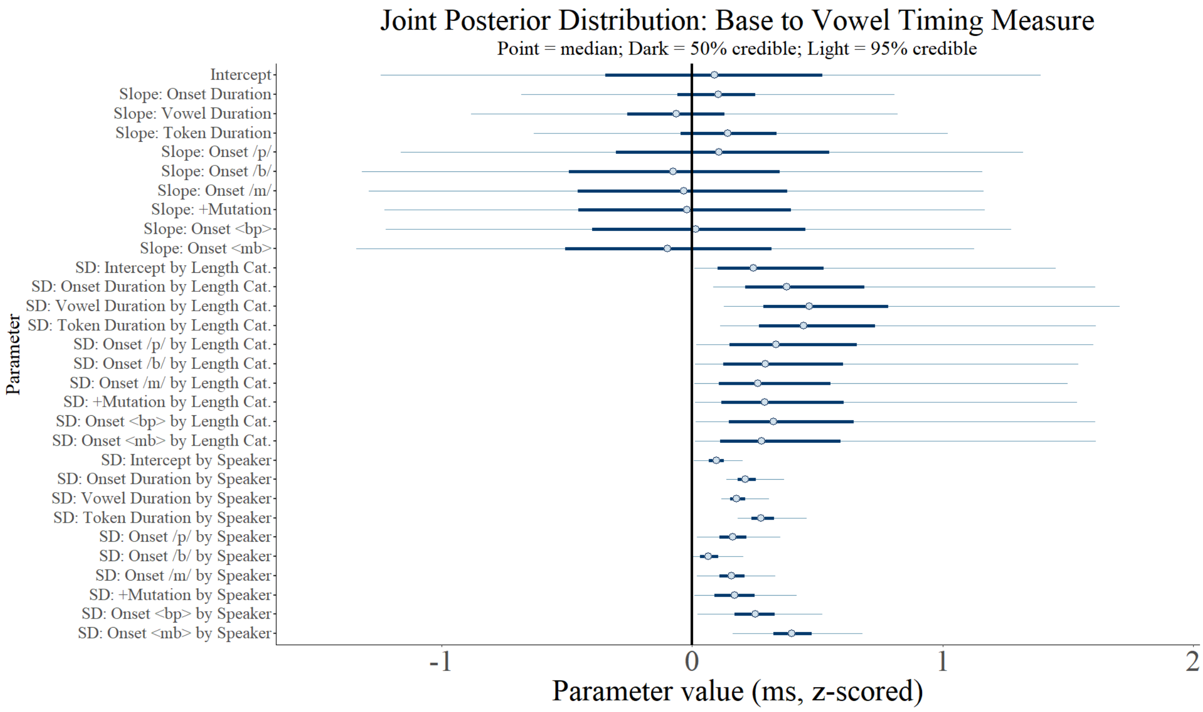

Figure 23 *Joint posterior distribution of population-level effects on base-to-target timing measure and standard deviations for random effects. No effect is remotely credible, indicating that variation in the selected timing measure cannot be predicted on the basis of the independent variables and random effect structure used to construct the model.*

Credible intervals for categorical predictors (onset identity and mutation status) are extremely wide, indicating a high degree of uncertainty and a null effect as the most frequently observed outcome in the joint posterior distribution. On this basis, it is safe to say the model does not provide any evidence to support a timing/rhythmic distinction between mutation-derived homophones (i.e. *a bpá – a bá* and *a mbá – a má*), and further that any possible timing distinction between observations is marginally more likely to be driven by token-specific phonetic duration parameters than by association with one of three discrete phonological categories /p^{γ} b^{γ} m^{γ}/.

The joint posterior distribution exhibits very wide credible intervals for standard deviation of all population parameters by length category, in contrast to relatively constrained variation estimated across speakers. It is conceivable that this is a simple timing by-product of the two syllable-counts and -structures. Interspeaker variability is most pronounced for the effect of mutation, both in isolation and in interaction with each of the two potentially mutation-derived onset phonemes (/b^{γ} m^{γ}/).

Model results for individual speakers and categories (i.e. across levels of the various random effects) can be visualised and examined by obtaining model predictions for representative simulated data. For this, 100 tokens of each target condition were generated, and random values from normal distributions were used to simulate plausible onset and token durations for these ‘targets’. This distribution was centred on mean 0 for token duration and for duration of onset /m^{γ}/ in line with observed values in the actual data. Mean 0.1 was used for onset /p^{γ}/ duration, to reflect slightly longer observed durations associated with this phoneme. Likewise, mean -0.25 was used for onset /b^{γ}/ duration which had slightly below-average durations in the data. Vowel durations were centred on mean 0 for /b^{γ} m^{γ}/, and on -0.1 for vowel duration after /p^{γ}/ (i.e. slightly shorter vowel durations after an aspirated onset). Model predictions for how tokens with these hypothetical values would be aligned according to the base-to-target timing measure were then obtained using the `predict()` function in R.

For evaluation of cross-participant variation, model predictions for 95% credible intervals are presented on an individual speaker basis in Figure 25. These individual plots have been arranged such that differences in model predictions for the simulated data across onset phonemes, mutation status within onset phonemes, and target structure can be considered in turn. For interpretative clarity, Figure 24 first provides an annotated version of one of Figure 25’s panels, applicable also in broad terms for equivalent depictions of model predictions for simulated data in Sections 4.3.5 and 4.3.6. Although tedious, this format allows for the most transparent presentation of predictions, and in its own right underscores the variability and uncertainty which prevents the inference of a straightforward link between morphophonology and this particular proxy-measure of P-centre location.

A difference between conditions – in this case with respect to timing as measured by the base-to-vowel duration – would appear as sets of CIs with minimal overlap. By contrast, highly overlapping CIs indicate that the model estimates no reliable or predictable difference between the two conditions. This is effectively what can be seen between mutation conditions of /bˠ mˠ/ in Figures 24 and 25 for target timing, and is consistent with the lack of a credible non-zero slope seen for the mutation parameters in the joint posterior distribution (Figure 23).

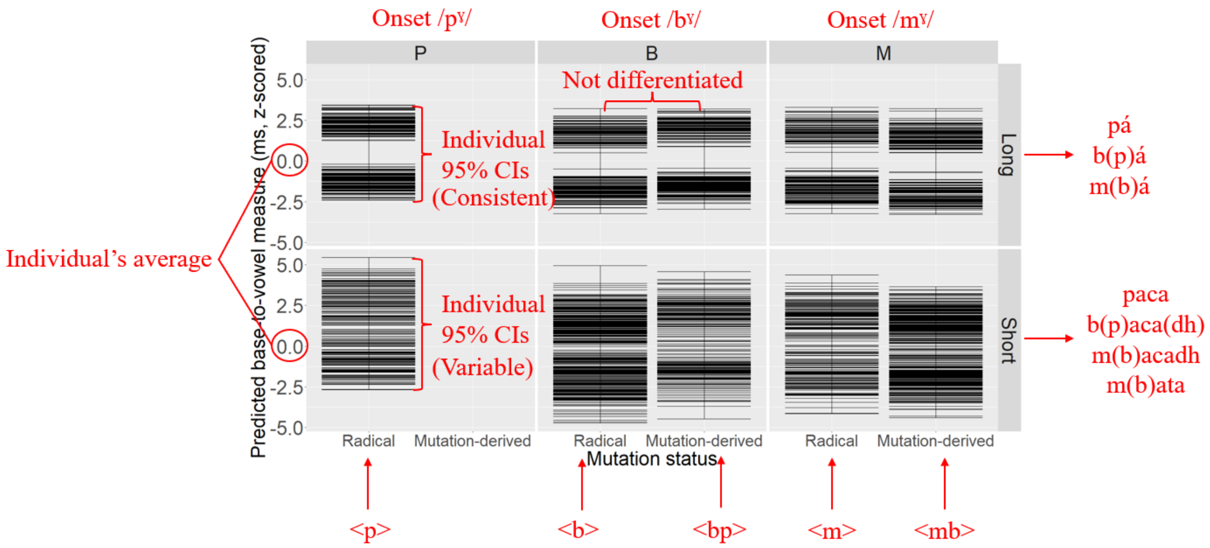

Figure 24 *Example panel from Figure 25 (below), showing model predictions for datapoints simulated for participant CI1. For each speaker, the model has made predictions for the value of the base-to-vowel timing measure of hypothetical tokens of the 12 targets in the metronome task. 95% credible intervals are plotted for the model's predictions per simulated token, separated by onset phoneme, mutation status within phoneme, and target type (long-vowel monosyllable or short-vowel disyllable). Some conditions show more variability in their predictions (e.g. all disyllabic targets for this speaker).*

Turning now to Figure 25 on the following page, while substantial variability is evident for most participant's predictions, three stand out in particular for tremendous uncertainty in predictions of timing measure value for one or both length categories: CI1, CI4, and CO2. For CI1, the uncertainty is much greater in simulated short-vowel disyllables than in long-vowel monosyllables, while the opposite is true of predictions for CI4 and CO2. By contrast, predictions are relatively consistent by category for participants CI2, CO1, and DE3.

With regards to emergent differences – or lack thereof – between mutation-derived homophones, under the hypothesis that mutation-derived targets will bear some resemblance to their radical counterpart (i.e. the unmutated form of the target lexical item), one would expect timing measures for mutation-derived /bˠ/ <bp> to approximate those for /pˠ/, and those for /mˠ/ <mb> to approximate those for /bˠ/. With longer durations and earlier P-centres characterising /pˠ/, this would be evidenced by higher predicted timing measures for <bp>, and slightly lower ones for <mb> to match /bˠ/'s late P-centre. This plainly does not emerge as a consistent or credible population-level effect. It is most credible as a possibility under predictions for CI1 and CO1. For the remaining participants, it falls *within* the realm of credibility for such a pattern to emerge, but this is alongside a vast range of other equally or more credible possibilities.

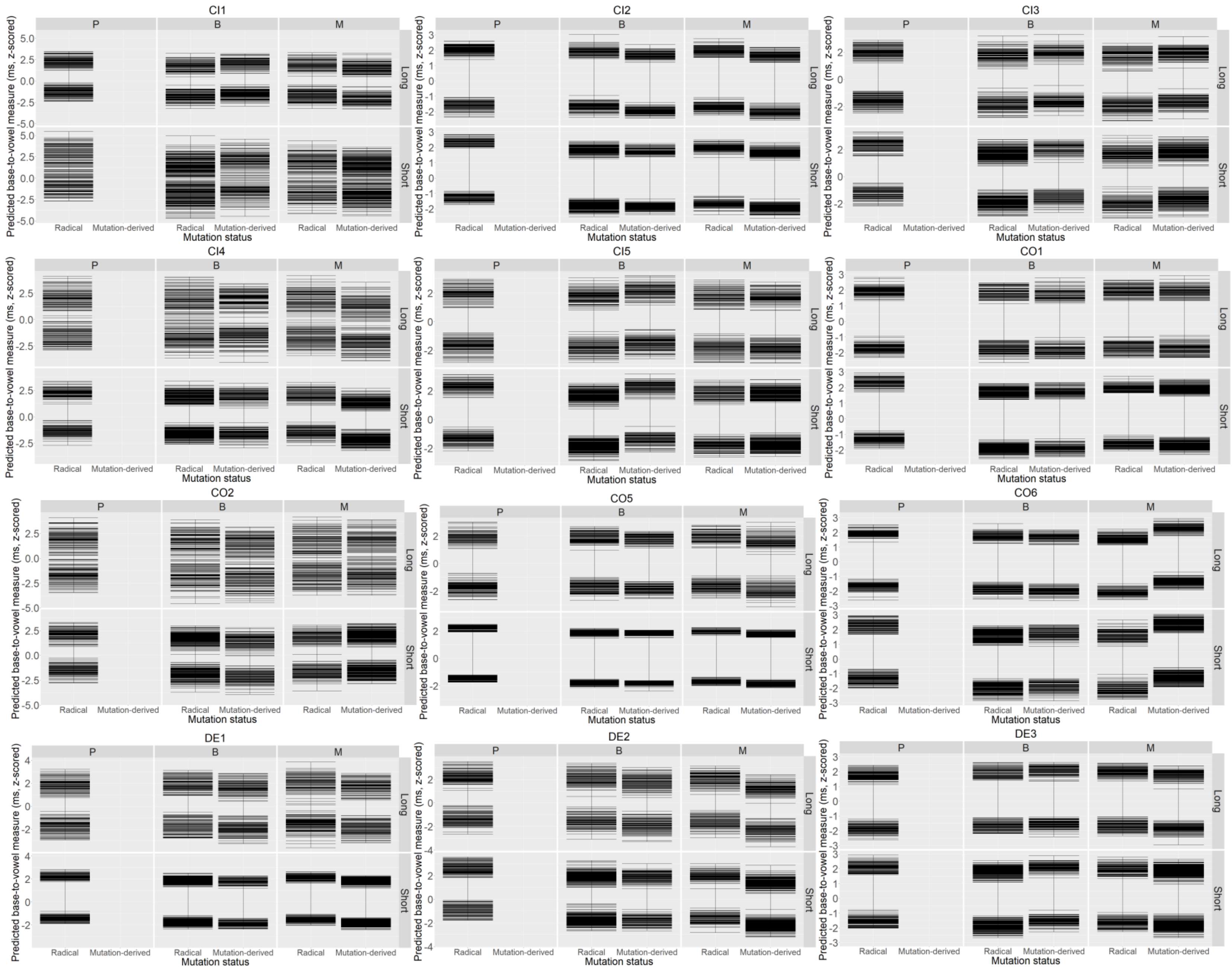

Figure 25 *Predictions of base-to-vowel timing measure across target conditions in simulated data, showing marginal credibility of later timing for some speakers' /pˠ/, and no consistent effect of mutation.*

Further and more exhaustive description of the Figure 24 predictions is possible, as is the further exploration of predictions in different formats and presentations. The utility of such description and exploration for the drawing of meaningful inference is extremely limited in light of such obvious uncertainty and variability. With reference to RQ1a, then, it seems clear that there is no positive evidence for this particular timing measure, as a situation-forced proxy of P-centre location – in the context of the available data, modelled using these particular parameters – being meaningfully tied to morphophonology. This does not exclude the possibility of morphophonological effects on P-centre location, which could conceivably emerge in data collected under less confounding experimental circumstances, but it certainly does not provide any positive support for the proposed hypothesis.

4.3.5 Statistical predictors of target onset duration

The next model examines target onset duration. Alongside the vowel duration model in Section 4.3.6, this addresses the more general interest of RQ1, restated below – namely, whether initial mutation can be tied to phonetic instability in initial syllables' constituent parts. In this case, the question is whether mutation-distinguished versions of the phonemes /bˠ mˠ/ differ in duration. On the basis of previous investigations of mutated consonants' duration in the literature, and the results of the pilot study reported in Section 4.2, it was hypothesised that onsets would show no meaningful variation within phoneme categories as a function of mutation status.

> **RQ1:** Does initial mutation contribute to the apparent phonetic/phonological instability of word-initial syllables in Munster Irish (MI)?
> ***Hypothesis:*** Duration of onsets are unaffected by mutation, while syllable rhymes are. The latter makes initial syllables unstable for weight-reckoning purposes within individual lexical items.

To investigate this first for syllable onsets in the data, onset duration was specified as a dependent variable, with onset phoneme and mutation status as predictors, along with interactions between phoneme categories /bˠ mˠ/ and mutation status. A random slope was fitted by speaker as for the model of timing, but not by target structure; it seemed implausible that onset duration would be affected by this feature, and random effects come with a cost in terms of computational efficiency.

Timing measure was not included as a predictor largely because it did not seem likely that P-centre location (as, at least in principle, represented by the timing measure) would itself be a factor in onset duration. As discussed in Section 2.2, it is possible that P-centre location plays a role in weight-reckoning and PLP-assignment, traditionally considered to only involve the syllable rhyme.

However, these are to do with the effect of P-centre location on post-onset syllable constituents. The case could be made for including timing as part of a maximal model, with its predictive (in)utility emerging in the model results. From a practical perspective, however, this would have greatly hindered efficiency of model computation.

As for the previous model in Section 4.3.4, weakly-informative regularising priors comprising normal distributions with mean 0 and standard deviation 1 were specified for intercept, slope, sigma, and standard deviation. 2000 iterations were specified for each of four chains, with the first 1000 iterations discarded as warmup. Posterior predictive checks against the original data (Appendix A) indicate satisfactory model performance in terms of approximating observed datapoints' values.

Having established the broad plausibility of the model, we can turn to the credible intervals within which the model predicts the real value of the evaluated parameters to fall. The intercept for this model is an abstraction, as it represents the credible range of values for an unmutated onset which is none of /pˠ bˠ mˠ/ – that is, all four contrast-coded variables have a value of 0. Such items of course do not exist in the dataset provided, although they certainly do occur in Irish (e.g. /x/ is unmutated, is not bilabial, and is neither a stop nor a nasal). Population-level model parameters (Figure 26) estimate change with reference to this intercept, however, and as such it is only its general range which is of importance for model interpretation. The 95% credible interval for the intercept very nearly centres on 0, with an estimated mean of 0.21 and a spread of 1.11 in either direction. Recall that the input data were z-scored, and estimated change is therefore to be interpreted in terms of the number of SDs a given datapoint falls from a speaker's mean value.

Turning to model predictions for the simulated dataset (Figure 27), it is clear that for all speakers and in both target-structure categories, onset /pˠ/ is predicted to have the longest duration of the three possible onset phonemes, /bˠ/ to have the shortest, and /mˠ/ to be slightly longer than /bˠ/. Further, it shows absolutely no credible effect of mutation, neither independent of phoneme category, nor specifically for mutation-derived /bˠ/ (<bp>) or mutation-derived /mˠ/ (<mb>). That is, mutated /bˠ/ <bp> is not predicted to have longer, more /pˠ/-like duration than unmutated <b>, and mutated /mˠ/ <mb> is not predicted to have longer, more /bˠ/-like duration than unmutated <m>.

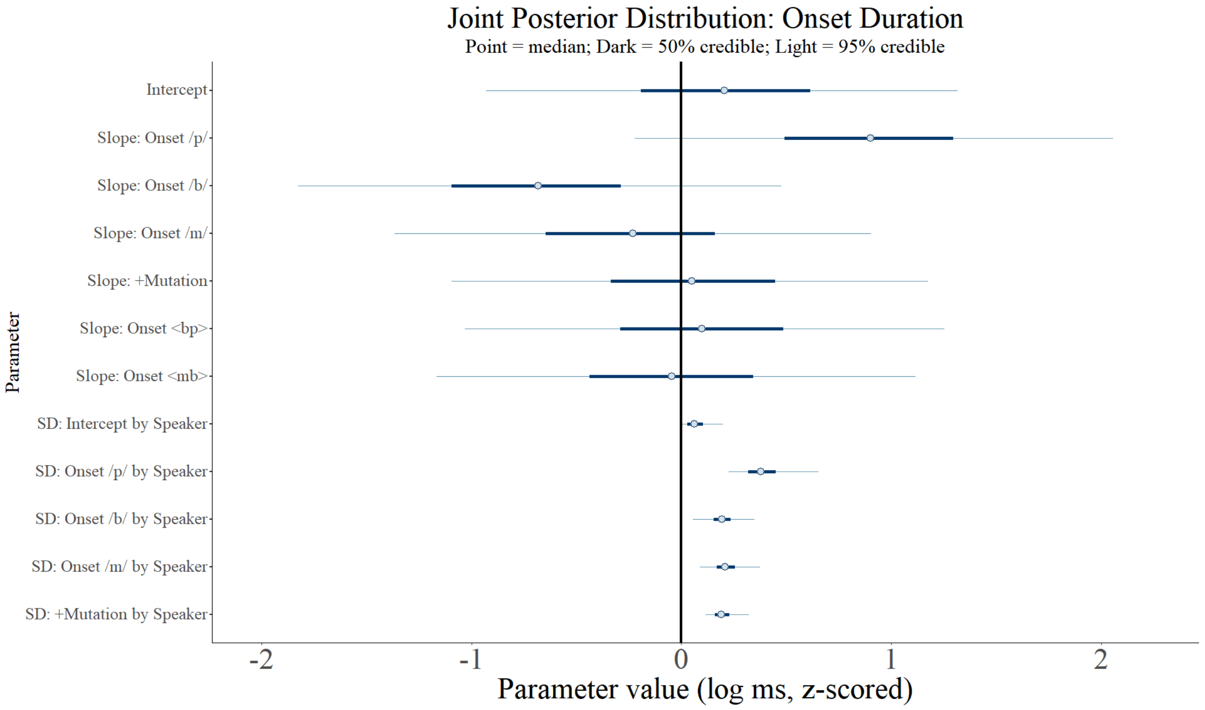

Figure 26 *Joint posterior distribution of population-level effects on onset duration, showing 95% credible intervals with 0 indicating a null effect. The intercept is estimated to be normally distributed around 0.21 and there are reasonably credible effects of phoneme on duration, regardless of mutation status.*

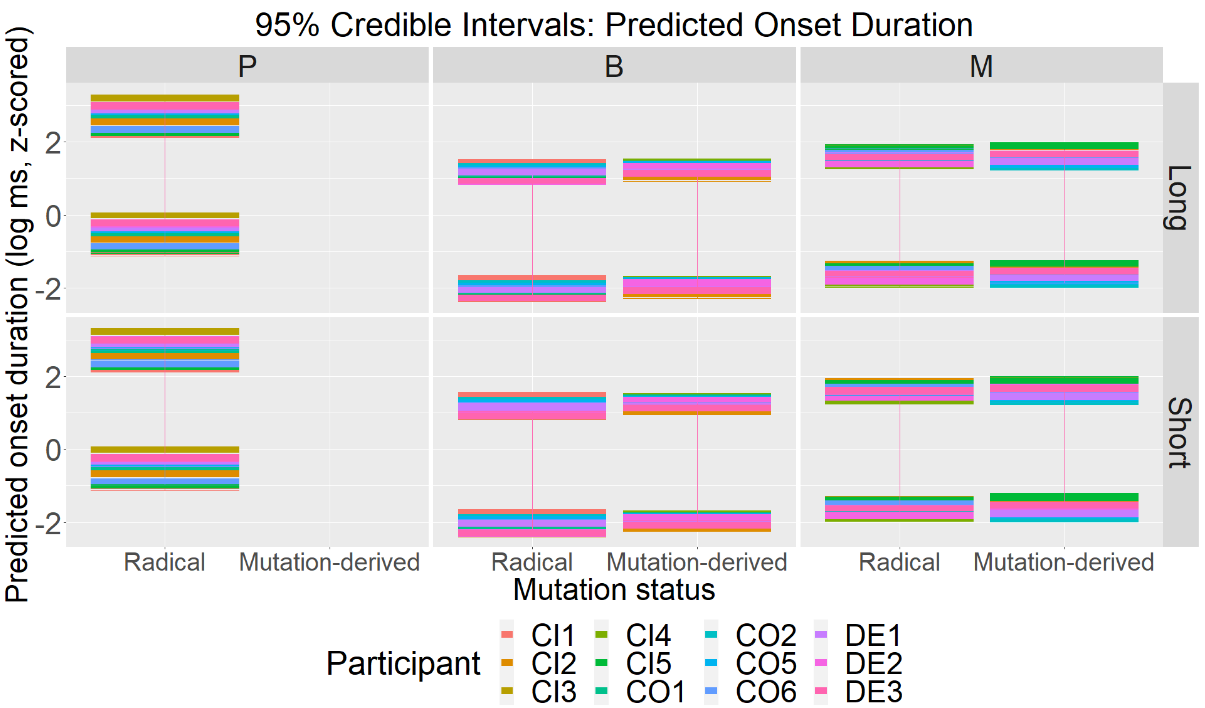

Figure 27 *Model predictions for onset duration in simulated data, with 100 tokens of each target condition per speaker. Minor by-speaker variation in predictions is evident, but it is clear that /pʸ/ is estimated to have the longest duration, followed by /mʸ/, followed by /bʸ/. Mutation-derived homophones are virtually identical in predicted duration.*

There is relatively modest variability across speakers for the model parameters, as indicated by low standard deviation estimates in Figure 26 (<0.5z) with very restricted credible intervals. It is also evident in Figure 27 that predictions do not vary much by speaker. The most cross-speaker variability is estimated for duration of /pˠ/. In summary, it is very clear that despite minor interspeaker variation, onset phonemes have a category-consistent duration regardless of mutation status and with no difference between the two target structures. This is in line with my hypothesis and addresses one element of RQ1.

4.3.6 Statistical predictors of target vowel duration

The final model considers predictors of target vowel duration, addressing RQ1 alongside the onset duration model in Section 4.3.5. It was hypothesised on the basis of the pilot study that mutated items would have shorter vowel durations. Vowel duration category-standardised by speaker was set as the dependent variable, with three independent variables considered as predictors: onset duration (log-transformed and speaker-standardised), mutation status, and the selected P-centre-proxy timing measure. Unlike for the previous two models, interaction between onset phoneme and mutation status was not included, as the predicted effect of mutation on vowel duration was expected to be equivalent for both <bp> and <mb>. As in the timing model of Section 4.3.4, random slopes were included for speakers and vowel length-categories, to allow for divergence between individual speakers and for the possibility of distinct behaviour of long and short vowels as a function of the predictors under consideration.

Timing was included in this model, in contrast to its exclusion in the onset duration model due to the greater plausibility of an effect of the same on vowel duration. This was assumed on the basis of statistical evidence in the literature for gradient but noteworthy effects of onset characteristics linked to P-centres on phenomena typically considered completely rhyme-dependent, supplemented by apparent differentiation of vowel durations within mutation-derived homophones in the pilot study.

As for the onset duration analysis, the model was supplied with weakly informative, regularising priors normally distributed around 0 with a standard deviation of 1 for intercept, slope, sigma, and standard deviation. Prior predictive checks run on the original data indicate that the model is not generating any particularly unusual values in comparison to what is actually attested for the same datapoints (Appendix A). The intercept in this model represents an unmutated target with a speaker-average onset duration and timing measure. An initial inspection of the model results in Figure 28 suggests that the only notable difference in vowel duration is between those following aspirated /pˠ/ and those following the other onset types. There is no obvious effect of mutation status on vowel duration, similar to the results for onset duration.

Consistent with a weak negative trend observed in pre-statistical exploration of the data, there is an approximately 53% credible negative relationship between onset duration and vowel duration centring around an estimated effect of -0.15z change in log-transformed vowel duration per 1z increase in log-transformed onset duration. In other words, it is just over 50% credible on the basis of the data, priors, and model specification that the real value of onset duration's effect on vowel duration falls between -0.1 and -0.3. Mutation status evidently does not impact vowel duration, at least not directly: its 95% credible interval robustly overlaps with 0, making it very unreliable on the basis of currently-available evidence to infer the presence of a non-null effect. There is a great deal of uncertainty associated with length category, the standard deviation of all effects for which are very widely distributed.

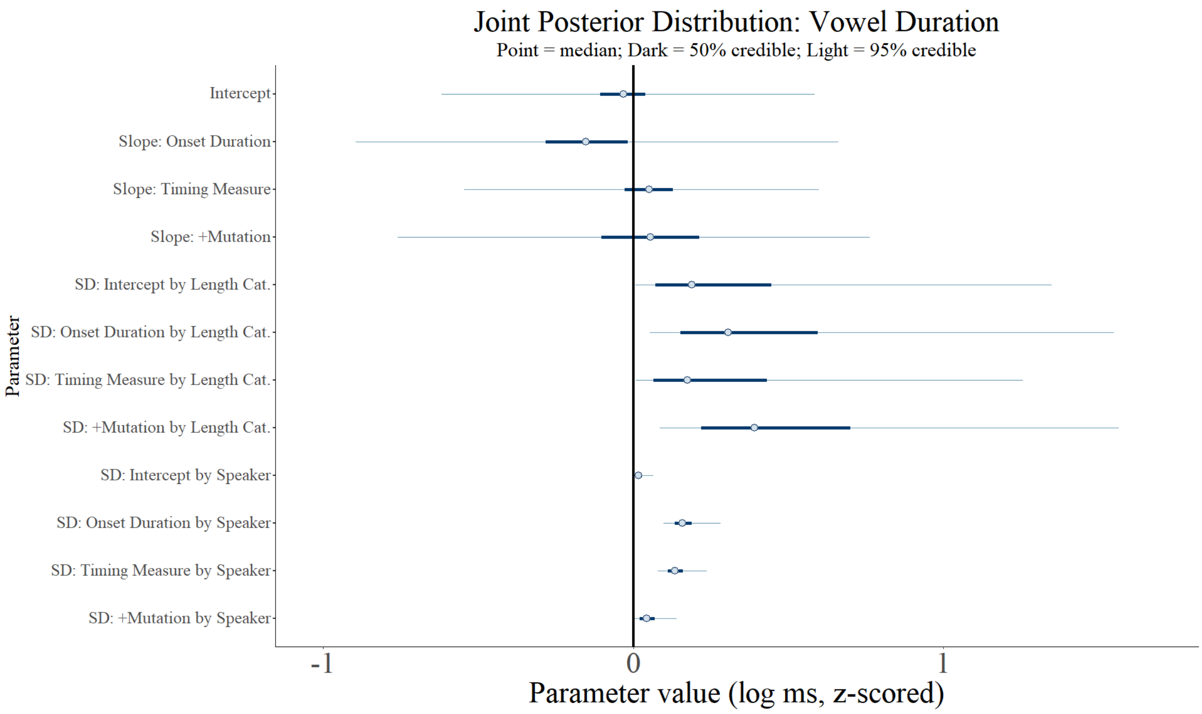

Figure 28 *Joint posterior distribution of population-level effects on vowel duration, showing 95% credible intervals*

Turning to predictions for the simulated dataset in Figure 29, random values were generated to represent log-transformed and speaker-standardised onset duration and the base-to-vowel timing measure, similar to the values generated for token and onset duration in the timing model (Section 4.3.4). The latter were taken from normal distributions with standard deviation 1 and means based on category averages from the earlier data exploration and normalisation: onset-duration means of 1 (1 SD above average), -0.25 (slightly below average), and 0 (average) for /pˠ/, /bˠ/, and /mˠ/ respectively, and timing-measure means of 0.1 for /pˠ/ (slightly earlier P-centre) and 0 for /bˠ mˠ/.

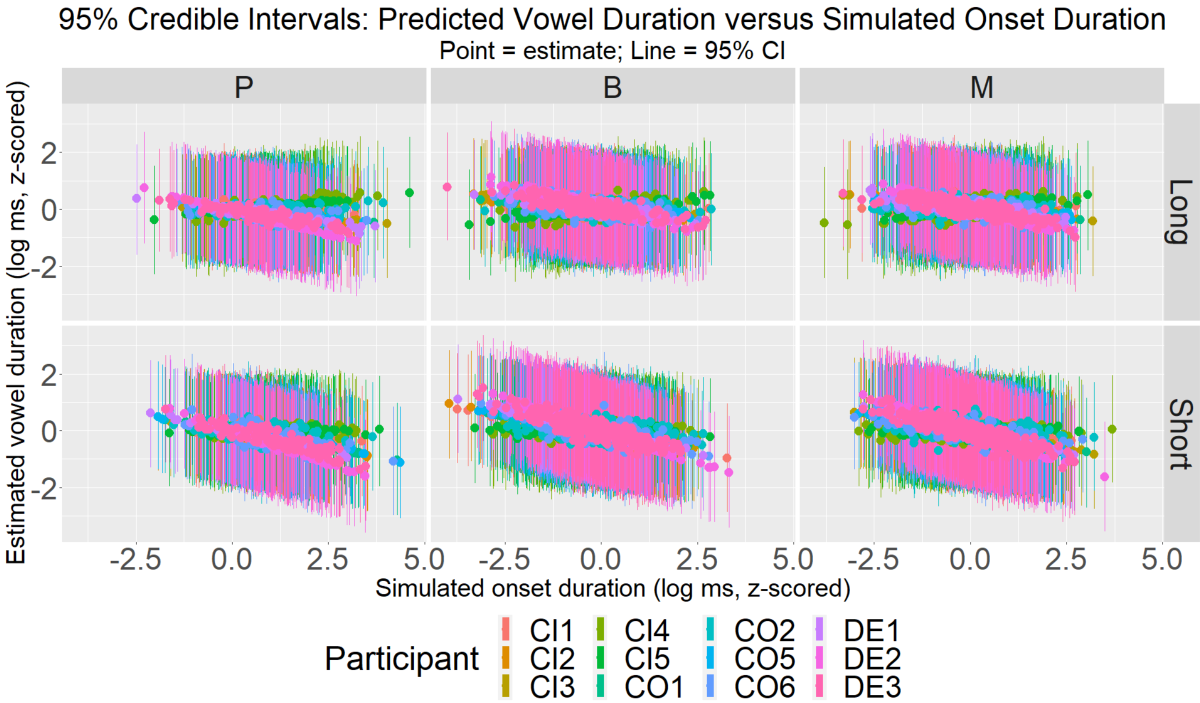

Figure 29 *Model predictions for vowel duration as a function of onset duration (points) with 95% credible intervals (lines) for simulated data, arranged by onset phoneme (columns) and target length-category (rows).*

Both interspeaker variation and an apparent difference in directionality and magnitude of the relationship between onset and vowel duration can be seen in Figure 29. The span of the 95% credible intervals (i.e. the lines surrounding each point-estimate) emphasise how uncertain the model's estimates of target vowel duration are. Insofar as any relationship between onset and vowel durations is evident, it appears to be consistent by speaker across target categories in being slightly negative.

This weak (and, to emphasise, only marginally credible) negative trend can be seen more clearly in Figure 30, in which a series of simple linear regressions are fitted for each speakers' predicted estimates. Note that Figure 29's point-predictions surrounded by credible intervals are a more faithful representation of the model's predictions – most notably in the often extreme overlap of credible intervals for vowel durations across the various simulated tokens. While it is possible to extrapolate and discuss patterns, as in the speaker linear regressions, it should be constantly borne in mind that for any degree of meaningful credibility, a speaker- and category-average 'real' vowel duration is considered entirely plausible under the model for effectively all onset durations.

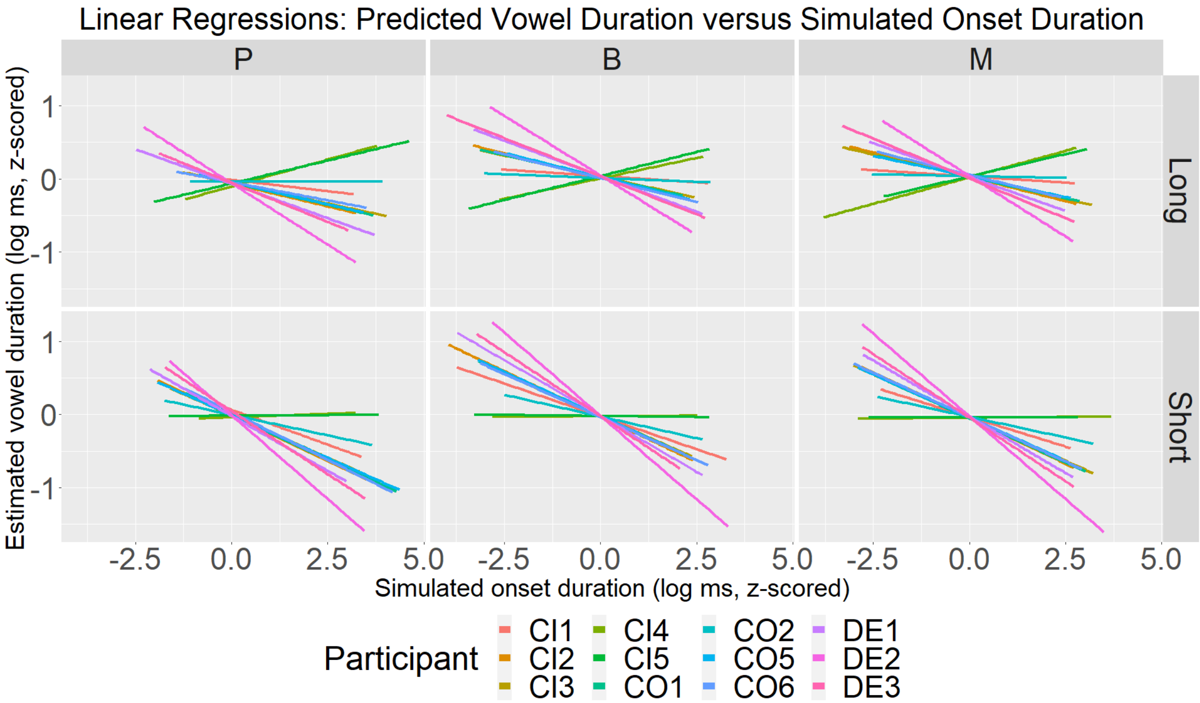

Figure 30 *Linear regressions by speaker for predicted vowel duration as a function of simulated onset duration (i.e. predictions from Figure 28 stylised as simple linear regressions).*

With the above qualification in mind, speakers can be divided into two groups on the basis of the apparent relationship between simulated onset duration and predicted tautosyllabic vowel duration. Predictions for the majority of speakers suggest a negative relationship between onset and vowel duration, with substantial variability in slope across speakers. For CI4 and CI5 there is apparently a *positive* relationship with slope of approximately 0.25 in long-vowel monosyllables and no relationship at all in short-vowel disyllables. Predicted slopes for all speakers decreases by approximately 0.25z for all speakers between long-vowel monosyllables and short-vowel disyllables, yielding a slope of 0 for CI4 and CI5 (i.e. no change in vowel duration as a function of onset duration) and more steeply negative slopes for the other ten speakers.

In other words, under this extrapolation with its requisite stipulations and interpretative precautions, for most speakers there is a slight reduction in vowel length as onset length increases, and this is more pronounced for short vowels than for long ones. The implications of this for the main phonetic correlate of phonological weight (and the reckoning thereof) are unclear. In one sense, it is surprising to see a more pronounced trimming of short vowels in the presence of increased onset duration than for long vowels, at least under the hypothesis that such a reduction is the compensatory result of a post-P-centre syllable duration exceeding a phonologically specified maximum (as in the mora-sharing scenario discussed for Malayalam in Section 2.3). In a more pragmatic sense, however, the difference in effect is relatively small and neither is particularly credible.

Turning back to RQ1, insofar as there is a credible negative relationship between onset and vowel durations, there is a marginal case to be made for an indirect effect of mutation on this phonetic analogue of syllable weight. Specifically, by virtue of syllable onsets frequently changing phoneme, the consequent differences in onset duration could subtly alter vowel duration. This would not, then, be a direct effect of mutation so much as an extension of typical durations associated with different phoneme categories.

Looking more directly at the relationship between vowel duration and target timing for the same simulated data does not prove particularly illuminating, as shown below in Figures 31-32. There is no straightforward or consistent relationship between the base-to-target vowel-onset duration and the duration of the target vowel; in the extrapolated by-speaker linear regressions (Figure 32) it is starkly apparent that negative, positive, and flat slopes are all attested. This stands rather in contrast to the predictions seen for simulated onset duration in Figures 29-30. Although the latter is weak and characterised by a similar degree of uncertainty surrounding predicted values, directionality of change in vowel duration concurrent with change in onset duration is relatively consistent across speakers and onset phonemes.

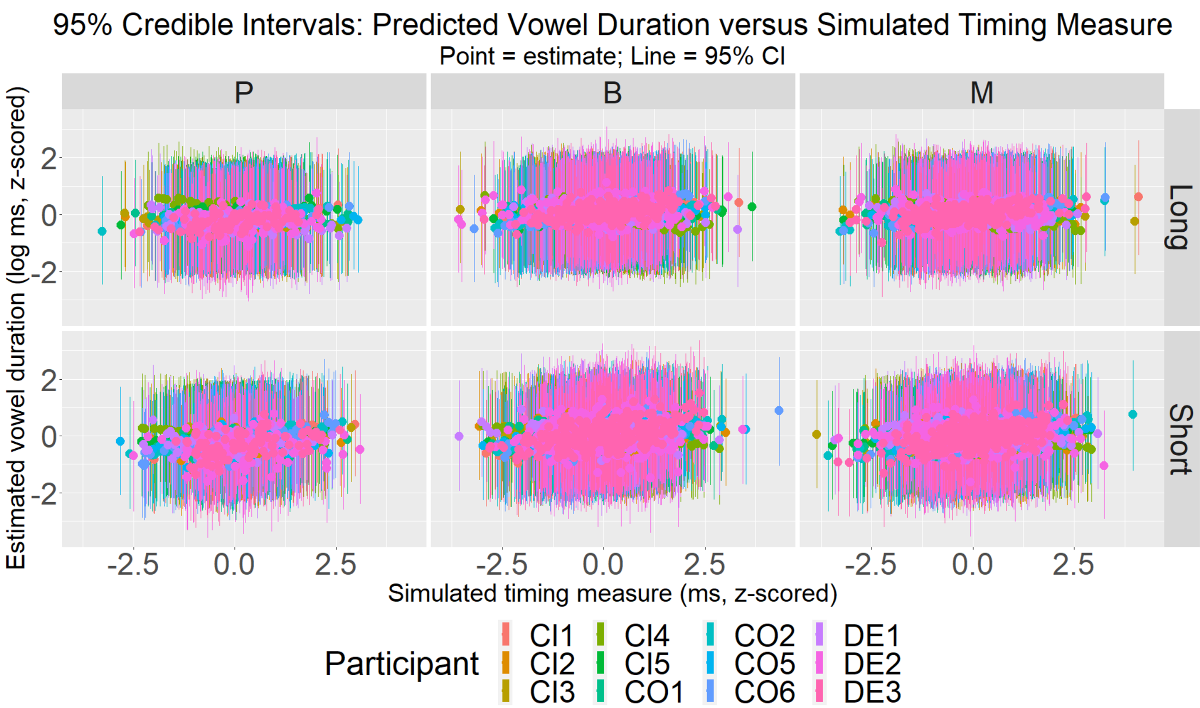

Figure 31 *Model predictions for vowel duration as a function of base-to-vowel timing (points) with 95% credible intervals (lines) for simulated data, arranged by onset phoneme (columns) and target length-category (rows).*

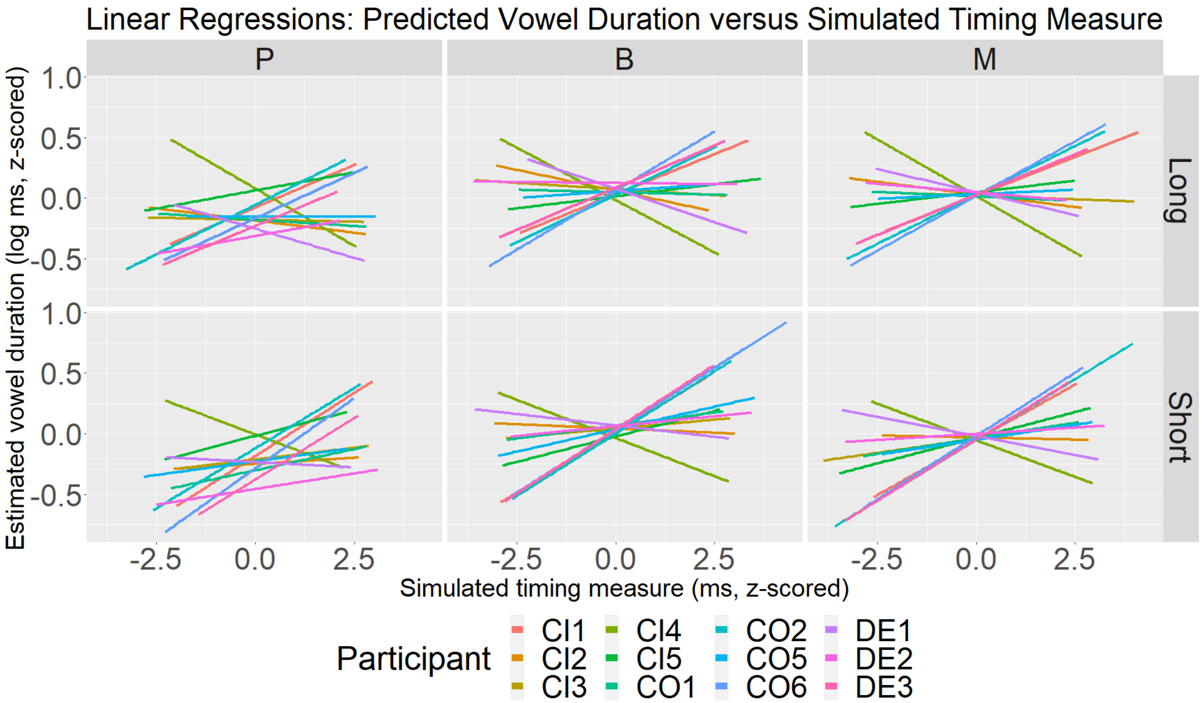

Figure 32 *Linear regressions by speaker for predicted vowel duration as a function of simulated onset duration.*

It is possible to describe individual speakers' patterns that emerge in Figures 31-32: CI1, CO5, and DE3, for example, appear to have a consistent positive relationship between the timing measure and vowel duration, which under the stipulated interpretation of the timing measure qua P-centre proxy would indicate that targets with earlier P-centres have longer vowels. In the first place, this is somewhat suspect; the category most associated with early P-centres and longer onset durations, /p^{y}/, has just been seen to fairly consistently condition slightly reduced vowel durations, including for speakers CI1, CO5, and DE6. Further, other speakers – and not just CI4 and CO6, who struggled with consistent temporal coordination – have directly contrary patterns, and some exhibit further variability across categories. It seems more likely in light of this that this measure, while perhaps the best of a bad situation in terms of indirect P-centre proxy measurements, may not be robust enough to capture meaningful data about P-centre location and its possible effect on segmental durations.

Based on the above, the answer to RQ1 is essentially negative; the present data do not support initial mutation driving initial syllables' apparent weight-instability. With regard to onset duration in Section 4.3.5, the hypothesis that mutation-derived homophonous onset consonants would have identical duration was supported. For vowel duration in this section, the hypothesis that vowel duration would vary across mutation categories (e.g. <bp> vs <b>) was not credibly supported. However, it is possible that longer onset durations condition clipping of vowel durations. This is insufficient on its own to support any claims about initial mutation and syllable weight but may be of interest for future exploration.

4.4 General inferences and chapter summary

To summarise the results of this chapter, based on evidence for the effect of derivational morphophonology on P-centre location reported in the literature and the results of a 2019 pilot study (Section 4.2), a metronome-synchronisation experiment was carried out to investigate whether mutation-derived homophones in (Munster) Irish were rhythmically distinguished from one another. RQ1 addressed two facets of this: whether initial mutation contributed to fluctuation in initial syllables' segmental durations, and whether P-centre location in mutation-derived homophones would correspond between lexical pairings or homophones (RQ1a). Results of three statistical analyses (Sections 4.3.4-4.3.6) support positive answers for neither.

The investigation was complicated by remote data collection forced by the COVID-19 pandemic (Section 4.3.1), which led to the selection of an indirect timing measure (distance between base-stimulus and target vowel onsets) as a P-centre proxy rather than a more direct measurement of timing between targets and the metronome beat.

Bayesian mixed-effect linear regressions suggest that (i) the relevant timing measure is not affected by mutation status, and only marginally influenced by durational properties of the onset and token as a whole (Section 4.3.4), (ii) onset consonant duration in targets is most credibly predicted by phoneme-category, with no effect of mutation status (Section 4.3.5), and (iii) vowel duration is weakly affected by onset duration for ten of the twelve speakers who took part, but does not correlate with the P-centre-proxy timing measure (Section 4.3.6).

In short, this experiment did not yield particularly interesting results from the perspective of rhythmic distinctions between mutation-derived homophones. The results contribute to the limited existing body of evidence which suggests total or near-total phonetic identity between radical and mutation-derived instances of phonemes, and is novel as a suprasegmental and prosodic approach to what has previously been considered only as a segmental matter. Additionally, from the perspective of variable weight-reckoning in initial syllables in Irish (RQ1), the results for marginally credible durational compensation between onsets and rhymes for a majority of participants have some relevance. Given the overwhelming frequency of initial mutation in Irish, fluctuation in phonetic-durational and phonological-weight characteristics of initial syllables tied to alteration of a given lexical item's initial consonant across up to three different (and possibly very disparate) phonemes could be hypothesised to make such syllables unstable for temporal coordination of suprasegmental features such as intonation. At present however, this remains firmly conjectural. In Chapters 5-7 below, the behaviour of lexical- and phrase-level prosodic features are considered, independent of the perceptual rhythmic status of initial syllables.

5 REAL-WORD PROMINENCE INVESTIGATION

This chapter details an investigation of phonetic measures typically associated with phonological lexical prominence as a function of syllable type and position in Munster Irish, comparing data from 1928 and 2021-22. As detailed in Chapter 3, the position of PLP in the Munster varieties is a matter of substantial interest for both Irish dialectology, and formal phonological theories of metrical structure and PLP assignment. Recall that, broadly speaking, the ‘Munster’ or ‘Southern Irish’ PLP system has been described as placing PLP on a non-initial syllable within the first three syllables of a word if it contains a long vowel or diphthong (i.e. a heavy syllable) and, in words of three or more syllables, is preceded by syllables containing only short vowels (i.e. light syllables)[12].

Further, a special status is sometimes accorded to the sequence /ax/, which may attract PLP in peninitial position, although authors vary with regard to their account of this; some suggest an intermediate weight category for /ax/ syllables. The expected PLP location in sequences with more than one heavy syllable in the relevant domain is somewhat less clear, and apparently subject to regional variation in foundational dialect descriptions. In general, formal phonological accounts have started from the position of non-initial PLP obtaining only when a single heavy (or /ax/) syllable occurs in the PLP domain, and to this end have suggested various ways of accounting for apparently sporadic extrametricality of initial syllables using rules or constraints dealing with the construction and evaluation of metrical feet.

The investigation had its origin in my annotation of digitised wax cylinder recordings from the 1928 Doegen Collection held online by the Royal Irish Academy (www.doegen.ie). These recordings were made primarily by Wilhelm Doegen (1877-1967), a German phonetician who came to Ireland to document Irish varieties at the invitation of the Irish government. I undertook my initial survey of the Munster recordings contained in this collection with a general interest in possible cases of rising pitch accents and/or late-aligned falls as perceptual drivers of PLP-location reanalysis à la Blankenhorn (1981) and Windsor *et al*. (2018). A number of highly ambiguous cases of phonetic prominence emerged, and it gradually became clear that one of the main assumptions underpinning an AM-style classification of pitch accents could not be made: the reliable identification of PLP. What often appeared in both typically ‘shifted’ items and ‘unshifted’ initial-PLP items was intensity-prominence on initial syllables followed by variably delayed high pitch; the former aligned with Old Irish (and modern Connacht and Ulster) initial PLP, and the

[12]Subject to variability across authors and between dialectological monographs and formal phonological summaries thereof. The reader is referred back to Chapter 3.3.1 for details.

latter Munster 'shifted' or 'forward' PLP. Figure 33 provides an example of such an ambiguous cases.

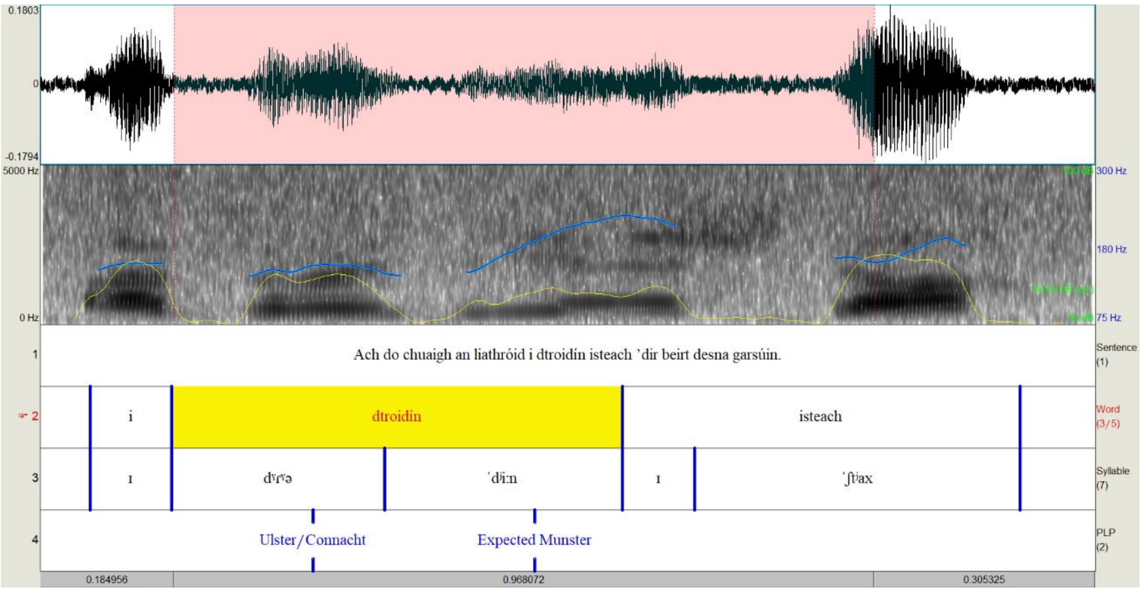

Figure 33 *Example of a light-heavy disyllable troidín 'fight.DIMINUITIVE' with higher intensity (yellow line) in the initial syllable and high F0 (blue line) in the final syllable, taken from Kerry speaker SÓC (farmer, born 1853, monolingual with no formal education).*

On the basis of this, I decided to investigate how phonetic prominence parameters were distributed over the course of polysyllabic words, with the aim of comparing acoustic findings with dialectological and philological descriptions, and with the 'facts' of Munster PLP as laid out for theoretical reconciliation in formal phonological accounts. RQ2/a (reproduced below) address this topic by examining (i) correspondence between received descriptions and available phonetic data (RQ3), and (ii) the extent to which there is a uniform 'Munster' PLP system at all (RQ2a).

> **RQ2:** Do any phonetic prominence parameters align with descriptions of lexical prominence/'stress' location in MI?
> ***Hypothesis***: One or more non-pitch parameters align with unshifted initial prominence (as in Ulster and Connacht), while salient pitch events align with non-initial syllables.
>
> > **RQ2a:** Are lexical prominence patterns consistent across Munster subvarieties?
> > ***Hypothesis***: Regional varieties differ from one another.

A parallel investigation of the same features was carried out for storytelling data from modern speakers of the Munster varieties in question to allow for the examination of generational change in prosody between the two eras, given the shift from heavy Irish dominance to a greater (omni)presence of English in the regions. This is encapsulated in RQ2b. Generational change is a particularly important point to address, as those few studies in the literature which have collected original acoustic data on one or more Munster varieties to study PLP rely on continuity between descriptions based on nearly century-old author impressions and modern speakers of these varieties.

> **RQ2b:** Have lexical prominence patterns in MI changed between 1928 and the present day?
>
> ***Hypothesis*****:** 1928 speakers have distributed/ambiguous prominences, while present-day speakers show more straightforward 'shifted' prominence under expected conditions.

In Section 5.1, I outline the 1928 and 2020-21 data collected, the speakers recorded in both generations, and annotation of the data. This is followed in Section 5.2 by a systematic exploration of the distribution of four acoustic measures over syllable positions: maximum intensity (Section 5.2.1), maximum F0 (5.2.2), F0 range (5.2.3), and vowel duration (5.2.4). Each of the four measures is explored in a Bayesian mixed-effect linear regression as a function of syllable position for di- and trisyllabic words in both the 1928 and 2020-21 data, for a total of 16 models (four per subsection). The chapter concludes in Section 5.3 with a summary and discussion of implications with respect to RQ2a-b, and relates the findings to the nonword production experiment described in Chapter 6.

5.1 Methods and materials

As outlined above, historical data from 1928 were obtained from the Royal Irish Academy's Doegen Archives. These are freely available online as .mp3 files, along with orthographic transcriptions. Initially, I only examined retellings of a single story (*An Mac Scaiptheach* 'The Prodigal Son') which participants had been directed to retell in their own words, but later this was expanded to include all available prose-type storytellings (excluding isolated sentences/phrases, word lists, songs, poetry, or highly stylised poetic storytelling). This made for a total of 26 story (re)tellings from 20 male speakers (with 5 speakers contributing more than one story) across 5 counties: Kerry, Cork, Waterford, Clare and Tipperary. The varieties of the latter two counties went extinct in the latter half of the 20th century. Doegen informants included in the present study are listed in Table 6.

Speaker birth-years ranged from 1846 to 1892 (ages 36 to 82 at the time of recording). By time-depth, and given the conservatism exhibited by many of the speakers, this places at least some of these recordings as roughly contemporary to O'Donovan's (1845) and Molloy's (1867) grammars of Irish. Two of the Kerry speakers in the collection – SÓC (b.1853) and MMG (b.1892) – were reported to be monolingual in Doegen's biographical notes; both were from the far west coast of the county (Baile an Sceilge and Dún Chaoin, respectively), and neither had any formal education. The sustained existence of monolinguals, even if rare by 1928, underscores the strength of Irish in the Kerry Gaeltacht as a robust community language at this time.

County	Speaker	Born	# Stories	Summary of available biographical notes
Kerry	SéÓC	1848	1	Farmer; limited schooling
	SÓC	1853	2	**Monolingual**; farmer; schooling
	AÓG	1857	1	Farmer; no formal education
	TÓCC	1862	1	Farmer and postmaster; schooling
	PÓR	1867	1	Fisherman; no formal education
	MMG	1892	1	**Monolingual**; farmer and fisherman; no formal education
Cork	MÓL	1862	1	Farmer; schooling; 12 years spent in USA
	CÓS	1866	1	Farmer, fisherman, and craftsman; schooling
	DÓC*	1871	1	Farmer; schooling; published autobiography *Scéal mo Bheatha* (1948)
	AÓL*	1872	1	Farmer and storyteller; schooling; first winner of Oireachtas na Samhna scéalaíocht [storytelling] competition
	PÓS	1873	1	Farmer; schooling; 10 years spent in USA
	SB	1888	1	Shopkeeper and fisherman; limited schooling
Clare	SÓE	1858	1	Farmer, storyteller, Land League activist; schooling
	LÓD	1866	1	Labourer and farmer; limited schooling
	JS	1883	1	Farmer; limited schooling
Waterford; E. Tipperary([T])	TÓCD	1846	1	Farmer; limited schooling
	PdB	1850	2	Railway worker, Waterford VP of Conradh na Gaeilge, original committee member of Coláiste na Rinne, poet, and author; schooling
	MT*	1878	3	Labourer, caretaker, and storyteller; no schooling; illiterate
	MÓC*	1887	2	Teacher; schooling
	SÓL[T]	1877	2	Farmer; limited schooling

Table 6 *Speakers (20, all male) from the Doegen Records included in the present investigation. Speakers marked with * were coincidentally used as informants for dialect descriptions by Ó Cuív (1944) and Breatnach (1947).*

For modern data, 14 participants (the same as those described in the previous chapter, reproduced below for convenience) were presented with the text of *An Mac Scaiptheach* (chosen somewhat arbitrarily to match the majority text in the 1928 data), slightly modified from the 1981 translation of the Bible (*An Bíobla Naofa*) published by An Sagart of Maynooth. This was first read aloud, and then they were directed to retell the story in their own words as best they were able. Thus, there were two files for analysis for each speaker – one reading, and one retelling – making for 28 recordings, roughly equivalent to the 26 available from the Doegen Records. This was the only task which all 14 participants were able to complete, as it required far less patience and stamina than the metronome (Chapter 4) or nonword (Chapter 6) tasks. The 2020-21 participants are presented below with a reproduction of Table 5 from Chapter 4.

County	Speaker	Born	Mother's L1	Father's L1	Highest education via Irish
Kerry	CI1	2001	Irish	English	Tertiary
	CI2	1997	Irish	Irish	Secondary; Mix at tertiary
	CI3	1964	Irish	Irish	Secondary; Mix at tertiary
	CI4	1993	Irish	English	Secondary
	CI5	1945	Irish	Irish	University
Cork	CO1	1975	English	Irish	Secondary; Mix at tertiary
	CO2	1965	Irish	English	Secondary
	CO3*	1932	Irish	Irish	Secondary
	CO4*	1943	English	Irish	Secondary
	CO5	1971	English	Irish	Secondary
	CO6	1967	English	Irish	Tertiary
Waterford	DE1	1959	English	English	Tertiary
	DE2	1991	Irish	Irish	Tertiary
	DE3	1973	Irish	Irish	Tertiary

Reproduction of Table 5 *from Section 4.3 (Participants in remote data collection, with * indicating participation in the story reading and retelling task only).*

Phonetic annotation and analysis of the collected recordings was carried out in Praat. All recordings were first broken down into sentences and/or phrases, then lexical items. After this, individual syllables were delineated, within which vowels were segmented and labelled on a separate tier to facilitate measurement of vowel duration. Segmentation was relatively straightforward, particularly since the measures to be extracted (with the exception of vowel duration, see below) are only minimally affected by precise location of syllable margins. However, it is worth noting that reference to, e.g., periodicity as visible in oscillograms generated by Praat was often impaired for the 1928 recordings due to the large amount of background noise in the digitised wax cylinder recordings. In these cases, there was greater reliance on auditory verification of syllable/segment boundaries in addition to visual assessment of spectrograms.

Lexical items were given orthographic labels, with phonetic transcription applied to the syllable level. All polysyllabic items were then labelled for weight-structure, according to the ternary weight-hierarchy under evaluation (i.e. long vowels and diphthongs as heavy [H], short vowels as light [L], /ax/ as intermediate [X]). This weight-labelling was not always straightforward, for instance in cases of conflict between orthographic vowel length or composition and what speakers produced. It was decided that defaulting to speaker production was most consistent with an acoustic-phonetic approach to the data. For example, an item such as *fiafraigh* 'ask, inquire' could be light-light /ˈfʲ**ɪ**(ᵊ)fˠɾˠɪgʲ/ or heavy-light /ˈfʲ**ɪə**fˠɾˠɪgʲ/ (by virtue of a diphthong in the initial syllable)[13]; under my treatment, individual instances of this item could be labelled as either LL or HL depending on whether a substantial second element could be identified in the initial syllable to define a diphthong. Such cases were relatively rare, but did arise – see Table 8 below for further examples.

Once labelled, all syllables in di- and trisyllables then had measures of intensity, F0, and duration extracted automatically using two Praat scripts (Antoniou 2013, modified from Crosswhite 2003, which logs durations of labelled intervals) and Kim (2008, modified from Daland 2004, modified from Welby 2003, which extracts minimum and maximum values for intensity, F0, F1, and F2 in labelled intervals, further modified to extract mean F0/F1/F2 values). Items containing undefined F0 or other estimation errors were discarded before proceeding. The selected measures for the three parameters in each syllable were: maximum intensity, maximum F0, F0 range, and vowel duration. These four measures were chosen as representative of phonetic characteristics typically associated with PLP, namely loudness, pitch (both level and excursion), and length. Other measures of syllable prominence, such as spectral tilt or source-excitation may be investigated in future, but measures for the present work were required to be (i) relatively straightforward in implementation, and (ii) recoverable with reasonable reliability from the qualitatively variable Doegen recordings.

F0 settings were configured to range from 50-300 Hz for male speakers, and 75-400 Hz for female speakers (applicable only to the 2020-21 data, as there were only male speakers in the 1928 Doegen recordings). F0 value for a given timepoint was then estimated using the acoustic periodicity detection algorithm provided with Praat, using the default time step of 0.75 divided by

[13]More traditionally /ˈfʲɪə**ɾˠh**ɪgʲ/ in Munster (e.g. Ó Cuív 1944: 117), but with medial /-fˠɾˠ-/ more commonly observed in the 2021-22 data.

the F0 floor set (i.e. 15 ms for male speakers using a pitch floor of 50 Hz, 10 ms for female speakers using a pitch floor of 75 Hz). The selected value for the F0 floor in turn determines the size of the time window over which intensity is calculated and weighted; for a 50 Hz pitch floor (i.e. male speakers), this window is 60 ms, while for a 75 Hz one (i.e. female speakers) it is 40 ms.

Once extracted automatically using the analysis settings and Praat scripts outlined above, each measure was assessed in R for approximate normal distribution within individual speakers. Decibels are a logarithmic scale to begin with. F0 measures in Hertz were converted to semitones with reference to 50 Hz as a base. As for their counterparts in the metronome data in Chapter 4, raw vowel durations in milliseconds were log-transformed. All measures, now log-normal, were then z-scored for each speaker (i.e. speaker-standardised) to allow for pooling across speakers with different intensity ranges and speech rates.

Turning to the breakdown of syllable-count and weight-structure categories represented in the data, disyllables by far predominated. As shown in Table 7, for both era-groups, there were approximately 4000 disyllables and roughly 400 trisyllables after removing items unsuitable for measurement due to issues in F0 and/or intensity tracking. Tetrasyllables trail distantly behind at less than 60 tokens in each era, and so were not included for analysis. As it is, such items are relatively rare in the Irish lexicon, especially as non-compounds. Instances of *seirbhíseach* /ʃɛɾʲɪvʲiːʃəx/ ‘servant’ and its variants comprise the majority of these tetrasyllables, with its frequent occurrence tied to the subject matter of *An Mac Scaiptheach* (i.e. discussion of the Prodigal Son’s father and his servants, in contrast to the Son’s penury).

	Disyllables	**Trisyllables**	**Tetrasyllables**
Doegen (1928)	3941	342	52
Modern (2020-21)	3758	425	55

Table 7 *Distribution of syllable counts for words in the 1922 and 2020-21 data.*

For disyllables, distribution of weight structures is virtually identical for the two era-groups as evident in Figure 34. A by-era breakdown of frequent items is provided in Tables 8-9. Note that these tabulations are based purely on the weight structure attributed to items in line with operational marking guidelines, and are unable to comprehensively reflect known variability in item realisation. For example, *raghadh* ‘would go’ in both Tables 8 and 9 is frequently monosyllabic /ɾˠaɪx/, whereas tokens of this contributing to the frequency distribution presented represent cases in which two syllables were sufficiently distinct for the item to be considered disyllabic for analytical purposes.

In both eras, light-light (LL) words predominate, followed by heavy-light (HL) items. After this, the remaining weight structures are much more scarcely attested. Notably, structures purportedly eligible for rightward PLP shift (LH, LX, HH, XH, and XX) are relatively infrequent in the disyllable data. For all figures hereafter, shift-eligible weight structures (in the broadest sense, i.e., any structure with one or more non-initial heavy or /ax/ syllable), have been marked with asterisks for convenience (e.g. *LH*).

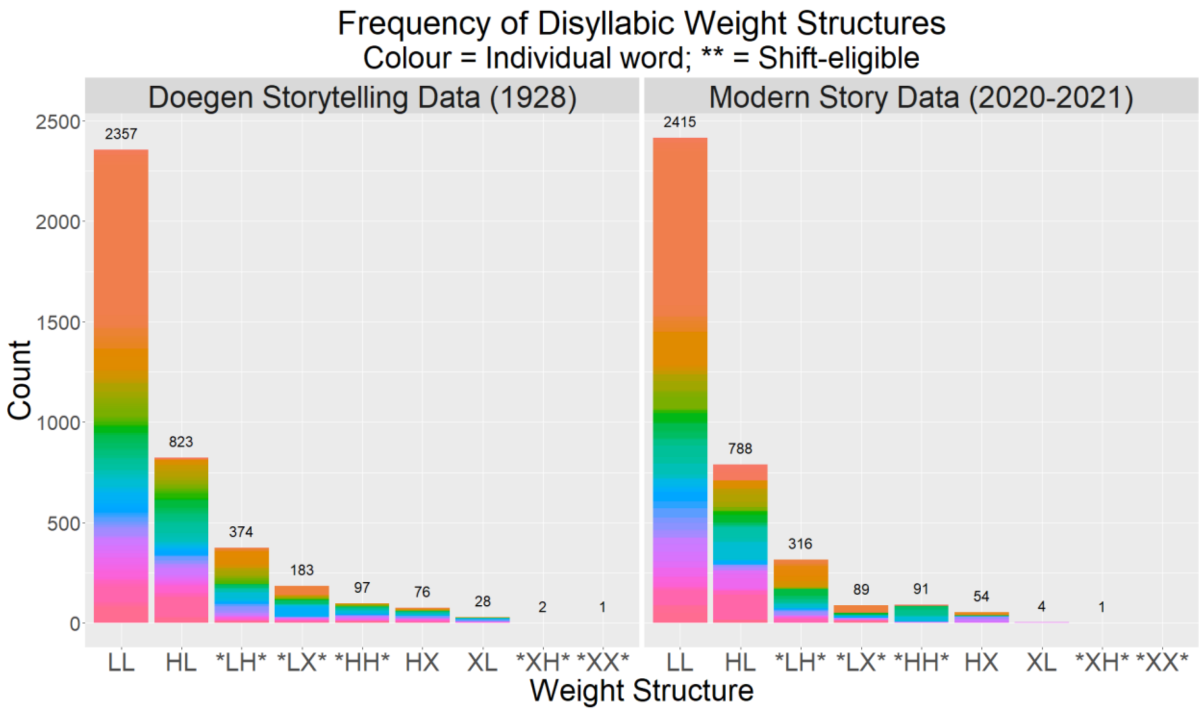

Figure 34 *Distribution of disyllabic words across weight-structure categories in the 1928 and 2020-21 data, with permutations of L(ight), /ax/ (X), and H(eavy) syllables. Items eligible for non-initial PLP in Munster are marked with asterisks. Colour represents individual lexical items within categories within eras (i.e. the same colours represent different lexical items in each column). Distribution and relative category frequency are practically equivalent between the two eras.*

1928 Data		**Disyllabic Weight Structure**					
		LL	**HL**	***LH***	***LX***	***HH***	**HX**
Frequency Rank	**1st**	*agus* 'and'	*tháinig* 'came'	*at(h)á* 'which are'	*amach* 'out(side)'	*(g)cónaí* 'home'	*mháireach* 'tomorrow'
	2nd	*athair* 'father'	*d'éirigh* 'arose'	*garsún* 'boy, lad'	*isteach* 'in(side)'	*prátaí* 'potatoes'	*aonach* 'fair'
	3rd	*aige/am* 'at him/me'	*éinne* 'anyone'	*arís* 'again'	*dhéanfadh* 'would do'	*trí(g)iú* 'third'	*réiteach* 'agree'
	4th	*arsa* 'said'	*oíche* 'night'	*Cearbhall* [name]	*imeacht* 'leaving'	*éireod* 'I will arise'	*thabharfadh* 'would give'
	5th	*gamhain** 'calf'	*bhíodar* 'were'	*fadó* 'long ago'	*raghadh** 'would go'	*d(h)innéar* 'dinner'	*aonacht* 'unity'

Table 8 *Top five most frequent lexical items across disyllabic weight structures in the 1928 data. Categories XL, XH, and XX omitted due to low frequency overall. * marks cases of an ambiguous short vowel + glide sequence changing from treatment as a light syllable (short vowel with a glide in the onset of the following syllable) to a heavy one (glide as second element of a diphthong).*

2020-21 Data		Disyllabic Weight Structure					
		LL	**HL**	***LH***	***LX***	***HH***	**HX**
Frequency Rank	**1st**	*agus* ‘and’	*tháinig* ‘came’	*dearthái*r ‘brother’	*amach* ‘out(side)’	*(g)cónaí* ‘home’	*aoireacht* ‘tending’
	2nd	*athair* ‘father’	*gamhain** ‘calf’	*arís* ‘again’	*thugadh* ‘was given’	*(d)tabharfaí* ‘you should give’	*millteach* ‘destructive’
	3rd	*duine* ‘person’	*ramhar* ‘fat’	*d(h)eartháir* ‘brother’	*isteach* ‘in(side)’	*dhiúltaíos* ‘I refused’	*oidhreacht* ‘heritage’
	4th	*chuige* ‘to him’	*óige* ‘younger’	*talún* ‘land’	*d(h)'itheadh* ‘would eat’	*drabhlás* ‘debauchery’	*raghadh** ‘would go’
	5th	*aige* ‘at him’	*caillte* ‘lost’	*mionnán* ‘kid’	*scaiptheach* ‘scattered’	*éadaí* ‘clothing’	*éineacht* ‘unity’

Table 9 *Top five most frequent lexical items across weight structures in the 2020-21data. Categories XL, XH, and XX omitted due to low frequency overall. * marks cases of an ambiguous short vowel + glide sequence changing from treatment as a light syllable (short vowel with a glide in the onset of the following syllable) to a heavy one (glide as second element of a diphthong).*

For trisyllables, the two era-groups diverge both in diversity and number of attested weight structures. This can be seen clearly in the disparate frequency distributions across weight-structure categories in Figure 35, and the respective breakdowns of item-frequencies in Tables 10-11. Light-light-light (LLL) predominates by far in the Doegen data, within which *abhaile* ‘(at/to) home’ emerges as the most frequent followed by *airgead* ‘money’. Heavy-light-light (HLL) trisyllables are the second most frequent weight structure for this group, for which *tuarasta*(*i*)*l* ‘hire, wage(s)’ is the most common, followed by *laethanta* ‘days’. For the modern data, it is shift-eligible light-heavy-light (LHL) which emerges as the most frequent, led by *sealúchas* ‘inheritance’. LLL is the second most common weight-structure, led by *eatarthu* ‘between them’ and *uireasa* ‘lack, need’.

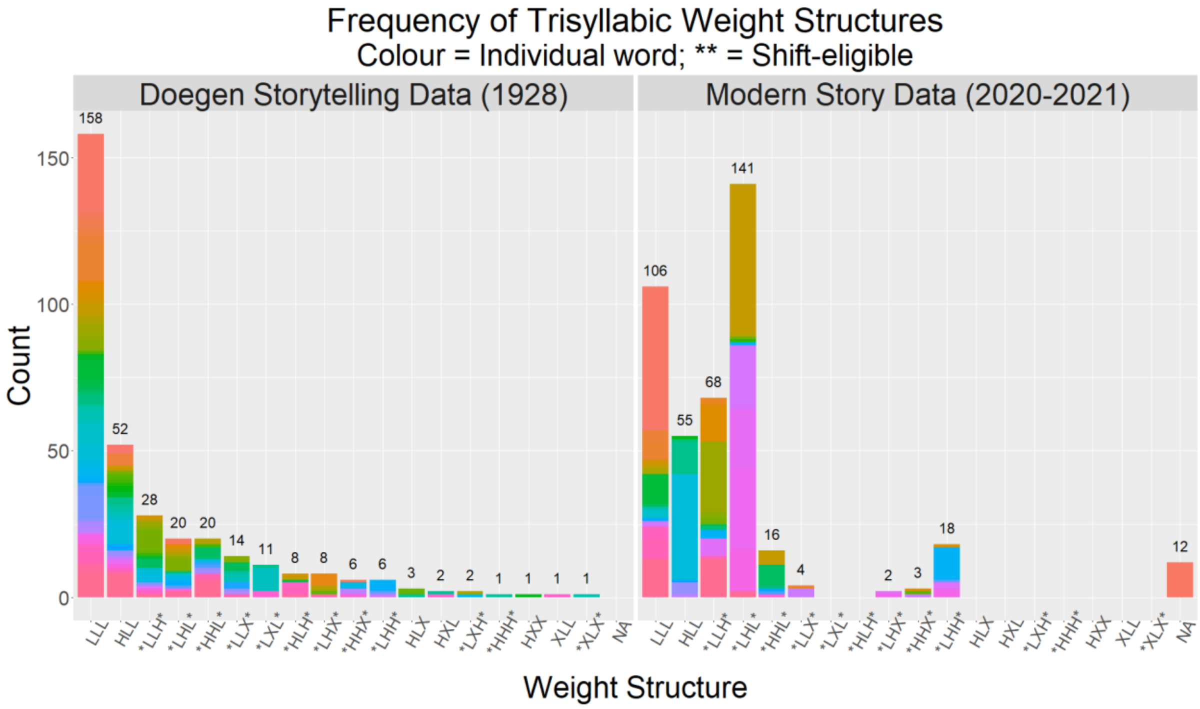

Figure 35 *Distribution of trisyllabic words across weight-structure categories for 1928 and 2020-21 data. Distribution across categories is notably different between the two eras, with fewer low-frequency structures attested in the modern data.*

1928 Data		Trisyllabic Weight Structures							
		LLL	HLL	*LLH*	*LHL*	*HHL*	*LLX*	*LXL*	*HLH*
Frequency Rank	1st	*abhaile* ‘(at) home’	*tuarastail* ‘wages’	*d(h)eartháir* ‘brother’	*d(h)'imíodar* ‘they left’	*tráthnóna* ‘evening’	*feargach* ‘angry’	*iasachta* ‘foreign’	*Áibhirseoir* ‘Adversary’
	2nd	*airgid* ‘of silver’	*laethanta* ‘days’	*feirmeoir* ‘farmer’	*thosnaíodar+* ‘they started’	*féithleoga* ‘scraps’	*deireanach+* ‘final’	*striapachaibh* ‘harlots’	*éistigí+* ‘listen’ [pl. imp.]
	3rd	*olainne* ‘of wool’	*aimsire* ‘of time/weather’	*ithimíst+* ‘let us eat’	*cabáiste+* ‘cabbage’	*chomhlíonadh+* ‘fulfilment’	*ocrach+* ‘hungry’	*gairdeachas* ‘rejoicing’	N/A
	4th	*eatarthu* ‘between them’	*ábalta* ‘able’	*bunoscionn+* ‘upside down’	N/A	N/A	*giobalach+* ‘ragged’	N/A	N/A
	5th	*imithe+* ‘left/departed’	*dréimire+* ‘ladder’	N/A	N/A	N/A	N/A	N/A	N/A

Table 10 *Top five most frequent lexical items across nine most frequently attested trisyllabic weight structures for 1928 data. * marks competing LLH and LHH versions of plural imperative verbs. + marks one of multiple items with the same minimum frequency (usually single tokens).*

2020-21 Data		Trisyllabic Weight Structures						
		LLL	*LHL*	*LLH*	HLL	*LHH*	*HHL*	*HHX*
Frequency Rank	1st	*abhaile* ‘(at) home’	*ceiliúradh* ‘celebration’	*cuirigí* ‘put’ [pl. imp.]	*láthairse* ‘presence’ [emph.]	*maraígí** ‘kill’ [pl. imp.]	*féithleoga* ‘scraps’	*aoiríacht+* ‘tending’ [var.]
	2nd	*uireasa* ‘deficiency’	*sealúchas* ‘inheritance’	*beirigí** ‘bear’ [pl. imp.]	*laethanta* ‘days’	*searbhóntaí+* ‘servants’	*ceiliúradh* ‘celebration’	N/A
	3rd	*eatarthu* ‘between them’	*seirbhísigh* ‘servants’	*tugaigí* ‘give’ [pl. imp.]	*fuarathas* ‘was found’ [var.]	*beirígí*+* ‘bear’ [pl. imp.]	*fíonúna+* ‘of a vine’	N/A
	4th	*airgead* ‘silver’	*dheartháirse+* ‘brother’ [emph.]	*seirbhís* ‘service’	*páirceanna* ‘fields’	N/A	N/A	N/A
	5th	*tagaithe* ‘come’ [var]	N/A	*maraigí** ‘kill’ [pl. imp.]	*dúradar+* ‘they said’	N/A	N/A	N/A

Table 11 *Top five most frequent lexical items across attested trisyllabic weight structures for 2020-21 (b) data. Fewer trisyllable structures were attested than in the 1928 data. * marks competing LLH and LHH versions of plural imperative verbs. + marks one of multiple items with the same minimum frequency (usually single tokens).*

5.2 Statistical analysis

In approaching the statistical modelling of the naturalistic PLP data, the aim was to examine the four selected prominence measures as a function of syllable position in order to compare predicted patterns (i) across lexical items of different weight-structures, and (ii) between era-groups. This addresses RQ2/a-b concerning the correspondence (or lack thereof) between previous descriptions of PLP location in Munster and the positional distribution of phonetic prominences (RQ2), and the uniformity of lexical prominence patterns synchronically (RQ2a) and diachronically (RQ2b).

This section describes a series of 16 mixed-effect linear regressions (Sections 5.2.1-5.2.4), which were carried out within a Bayesian framework. Should it be necessary, the reader is referred to the earlier outline of relevant Bayesian concepts and methods in Section 4.3.3. There were only two basic model structures – one for disyllables, and one for trisyllables – and where possible the treatment of the construction and evaluation of these has been abbreviated once introduced. It was necessary at this stage to treat di- and trisyllables separately due to a combination of computational efficiency and potentially variant behaviour of prominences in items of different syllable counts.

Before proceeding to the models themselves, beginning with Models 1-4 of maximum intensity in Section 5.2.1, the remainder of this section outlines the basic model specifications which were applied to all 16 models. Reference to these specifications is then abbreviated or omitted in Sections 5.2.1-5.2.4.

In all cases, syllable position was set as the independent variable attempting to predict the value of a given phonetic measure. This was treatment coded (see, e.g., Winters 2016: 117-118), yielding, for disyllables, a single dummy variable which identifies whether a given syllable is (1) or is not (0) the second and final syllable of a word. This arrangement makes the initial syllable the intercept, such that the slope estimated by the model represents change from initial to final position. For trisyllables, it was decided that the most efficient arrangement was to treatment-code syllables for first and third (final) position, such that the intercept (i.e. 0/'No' for both initial and final position) had a real positional value – namely a second/medial syllable (neither initial nor final). Thus, the estimate for each of the two dummy variables indicates change between the medial syllable and the relevant adjacent position.

In order to evaluate the relationship between prominence location and weight structure, the latter was specified as a random effect along with speaker. Recall that this allows for the model to estimate different slopes (i.e. direction and steepness of effect) across levels of a random effect – in this case, the effect of syllable position on prominence across different weight structures and speakers.

The inclusion of speaker as a random effect is straightforward: each individual speaker provided multiple datapoints, introducing a series of dependencies into the data. Allowing for a random slope lets the model engage with such sub-grouping.

Setting weight structure as a random effect, rather than as a predictor/independent variable in its own right, may seem less intuitive. Consider, however, that I am starting from a position of scepticism regarding the productivity of weight categories for PLP assignment in Munster Irish varieties (see hypotheses for RQ2/c). The main phenomenon these models are intended to address is the behaviour of phonetic prominences across syllable positions. By specifying a random slope for item weight structure, I allow for the possibility of different prominence distributions across the various structures. Any emergent category differences can be compared to descriptions of weight-sensitive PLP assignment, which may or may not encourage future statistical analysis more directly focussed on syllable weight itself as a predictor of prominence.

Weakly informative regularising priors were specified for each model. Because all dependent variables evaluated were z-scored, the same priors used for the three models in Chapter 4 were considered appropriate for all 16 of the models presented in Sections 5.2.1-5.2.4. These set a normal distribution with mean 0 and standard deviation 1 as the prior for model intercept, slope, standard deviation, and sigma, with ‘LKJ(2)’ used for the correlation prior (see Section 4.3.3).

This setup starts the model from the sceptical assumptions that (i) intensity/pitch/duration in the ‘reference’ intercept syllable is most likely to be speaker-average (i.e. 0z), (ii) syllable position likely does not have an effect on these measures (i.e. a slope of 0z for change in syllable position), (iii) the effect of syllable position is unlikely to vary across speakers and weight structures (i.e. SDs of 0), and (iv) any departure from (i)-(iii) is highly unlikely to be greater than +2z or less than -2z. These priors are then jointly evaluated alongside the data to produce the joint posterior distribution of each parameter in the model. As in Chapter 4, each model comprised four chains of 2000 iteration, with the first 1000 iterations of each chain discarded as warmup (see earlier discussion in Section 4.3.3).

Due to the particular random effects structure in question, for interpretation of model results, a simple plotting of the joint posterior distribution of population-level effects and standard deviations (as for the models in Chapter 4) is not particularly informative. This gives blunt estimates of the effect of syllable position on the prominence measure in question, and of the amount of variability associated with variable weight structure, but does not show positional change in prominence for each weight-structure category. These simple representations of parameters in the joint posterior distributions are left for Appendix B, and are referenced sparingly in Sections 5.2.1-5.2.4. Instead, the crux of each model's interpretation is a plot of the 95% credible intervals for a given measure's value across syllable positions. These intervals are plotted for individual weight-structure categories, and intervals are colour-coded by subregion[14]. In this way, it is possible to evaluate intuitively and visually each model's assessment of a given phonetic prominence measure (i) by syllable position (RQ2), (ii) in each attested weight structure (also RQ2), and (iii) across Munster subvarieties (RQ2a). More attention is given to the interpretation of these by-weight CI plots for the first instance of one in Section 5.2.1 (Figure 38; Model 1, maximum intensity in 1928 disyllables).

In general, it is worth emphasising the caution required in interpreting what are in fact very preliminary models of lexical-level syllable prominence in these varieties. Further, any number of different approaches to model construction and evaluation could have been taken, and indeed may be explored for comparison in future[15]. My goal in this work is not to overstate the generalisability or conclusiveness of my findings. On the contrary, as a starting point for future bottom-up, data-driven work on Irish, I am far more interested in highlighting ambiguity that conflicts with received descriptions (and formal treatments thereof) than in leaping straight to another 'account' of lexical prominence in the region.

With this statistical and interpretative framing in mind, I proceed to discussion of Models 1-16 In Sections 5.2.1-5.2.4 below. These begin with maximum syllable intensity (5.2.1, Models 1-4), followed by maximum syllable F0 (5.2.2, Models 5-8), syllable F0 range (5.2.3, Models 9-12), and vowel duration (5.2.4, Models 13-16).

5.2.1 Maximum intensity across syllable positions

The first models to be considered are those of syllables' maximum intensities across positions in di- and trisyllables in the 1928 Doegen data (Models 1-2) and the 2020-21 present-day data (Models 3-4). Recall that intensity in decibels has been z-scored (i.e. standardised) by speaker for whom standard deviations across di- and trisyllables ranged from roughly 4-7 dB (1928) and 2-5 dB (2020-21). Model results in *z*-units refer to each speaker's standard deviation as 1z (e.g. a

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[14]This is more parsimonious than colouring by speaker (i.e. the actual random effect specified). Where divergence is evident within a region, necessary reference to individual speakers is made.
[15] See Röttger (2019) for discussion of 'researcher degrees of freedom'.

change of +2z between syllables is equivalent to +7 dB for a speaker with a standard deviation of 3.5 dB).

Model 1: Intensity in 1928 disyllables

Supplied with the priors outlined above, Model 1 was specified and run using the `brms` package in RStudio. The model converged without error, as confirmed by the posterior predictive check illustrated in Figure 36 below. Unlike for discussion of models in Chapter 4, illustrations of posterior predictive checks in this chapter are presented for consideration in order to show distribution of datapoints across weight-structure categories (a major factor in the uncertainty of some categories' estimates). Recall that such checks use the model to generate predictions for the original data as though their dependent-variable values (maximum syllable intensity, in this case) were unknown. By comparing the outcome of these predictions to the values observed in the data, one can assess whether the model is generating plausible output based on how closely the predictions match the real values in the data.

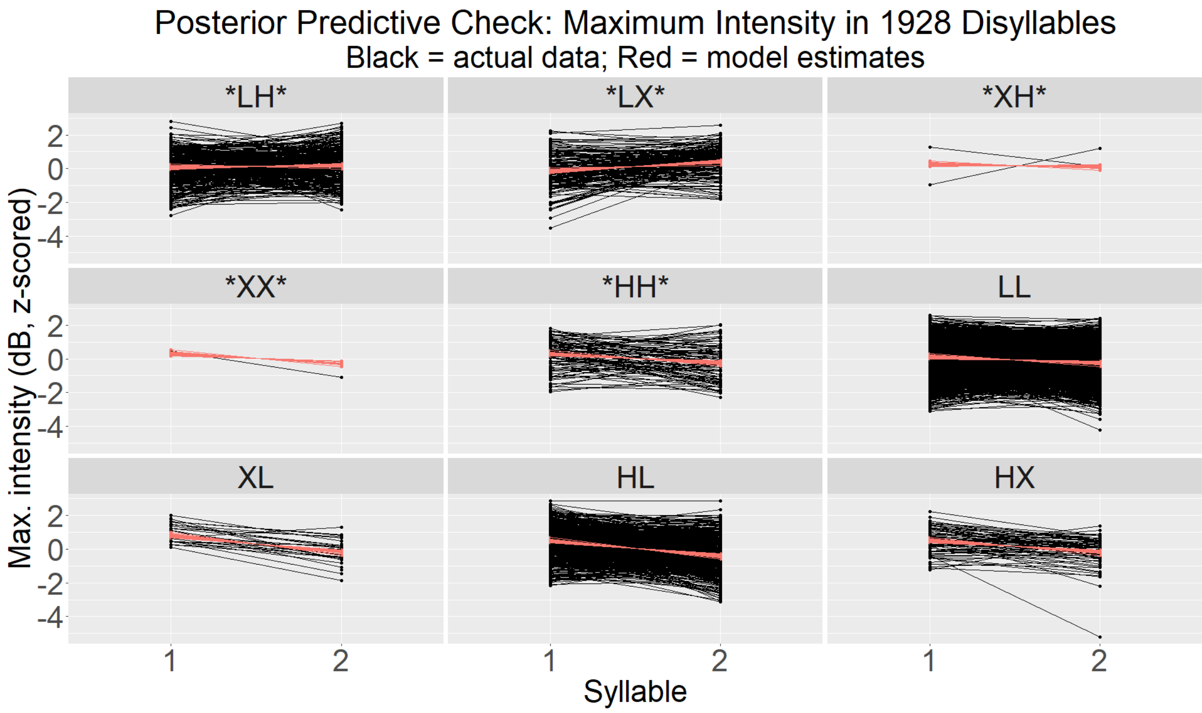

Figure 36 *Prior predictive check for Model 1 (maximum intensity across 1928 disyllables). The model's predictions for the data (red) comfortably match the observed values (black), and the uneven distribution of tokens across weight categories (number of lines in each panel) is starkly evident.*

We can now turn to the plotted 95% credible intervals for each of 9 weight-structure categories in Figure 37, in which intervals are colour-coded by region (Kerry, Cork, Waterford, Tipperary, and Clare). It was decided not to group now-extinct Clare and Tipperary with their nearest neighbours

(Kerry and Waterford, respectively). In the case of Clare, anecdotal similarities to the Irish of Inis Oírr came to mind. For (southeast) Tipperary, although traditionally considered part of the 'Déise' (a now-geographical term deriving from historical Gaelic sociopolitical considerations), the possibility of distinct behaviour from its southerly neighbour in Waterford should not be ruled out. In any event, for a very minor trade-off in labelling perspicuity, this was easy to investigate; should these two counties pattern with their neighbours, this will emerge regardless.

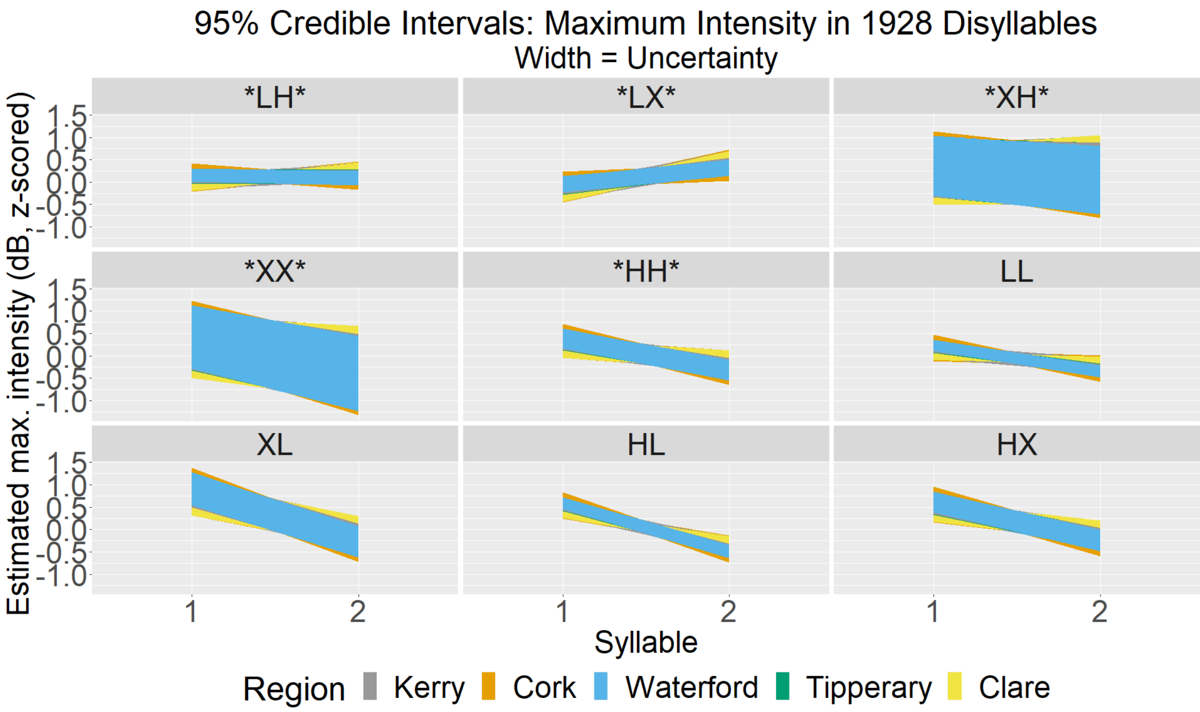

Figure 37 *95% credible intervals by weight structure from Model 1 (maximum intensity in 1928 disyllables), with Syllable 1 representing the model intercept. Wider intervals indicate a greater range of credible values (i.e. greater uncertainty).*

In Figure 37 and all remaining such plots in this and Chapter 6, each panel represents a weight structure. For each weight structure, 95% credible intervals for model estimates (the y-axis) are plotted for each syllable position (the x-axis). Credible intervals for each subregion are colour-coded; regional groups with identical or very similar estimates may obscure one another, in which case the visible region/colour is simply a matter of alphabetical order of plotting on the part of R. This means that alphabetically final Waterford's (blue) CIs have been plotted last and occupy the 'front' position. Width of intervals (i.e. coloured bands in each plot panel) indicates the degree of certainty in the model's estimation. A narrow band/CI represents a higher degree of certainty – that is, a narrower, more precise range of credible values. A wider band represents the opposite – a wider range of credible values, and therefore less certainty about any particular value within that interval.

Readily seen in Figure 37 is a clear split in terms of model certainty for maximum intensity across syllable position in different disyllabic weight structures, evidently driven by the amount of data available to the model for each category. CIs are dramatically wider for the XH and XX categories, which have between them only three observations in the data. XL has the next widest intervals, consistent with its having the next lowest token-count. For the remaining, more robustly attested six categories, the model is able to make estimates within a narrower range of 95% credibility. Turning first to targets which should exhibit uncontroversial initial PLP – HL, HX, LL, and XL – results look more or less in line with expectations: initial syllables are estimated to have higher intensity maxima than their final counterparts for all speakers in all regions. In general terms, slopes between syllable estimates are steeper for Waterford, Cork, and Tipperary speakers than for Kerry and Clare ones, but only slightly so.

For weight structures purportedly eligible for rightward PLP shift (LH, LX, HH, XH, and possibly XX), there is some variation across categories and across region-groups within categories. Final-syllable intensity prominence is only consistently predicted for LX items. It is worth noting, however, that this category is dominated in the data by the adverbs *amach* ‘out’ and *isteach* ‘in’ (43 and 38 out of 185 LX words observed, respectively). This was evident for both generations in Table 8 (Section 5.1), in which both items were in the top three most frequently attested for the LX category. These represent a small class of disyllables with final PLP in all dialects of Irish, not just Munster, deriving historically from compounds.

For comparison, a second (Model 1b) was run, excluding tokens of *amach* and *isteach*. This was otherwise identical to Model 1, but did not include these two high-frequency items in the data. The results of this are plotted in Figure 38 which shows results only for the LX category. Model outcomes for the other 8 weight-structure categories were identical and are therefore not repeated.

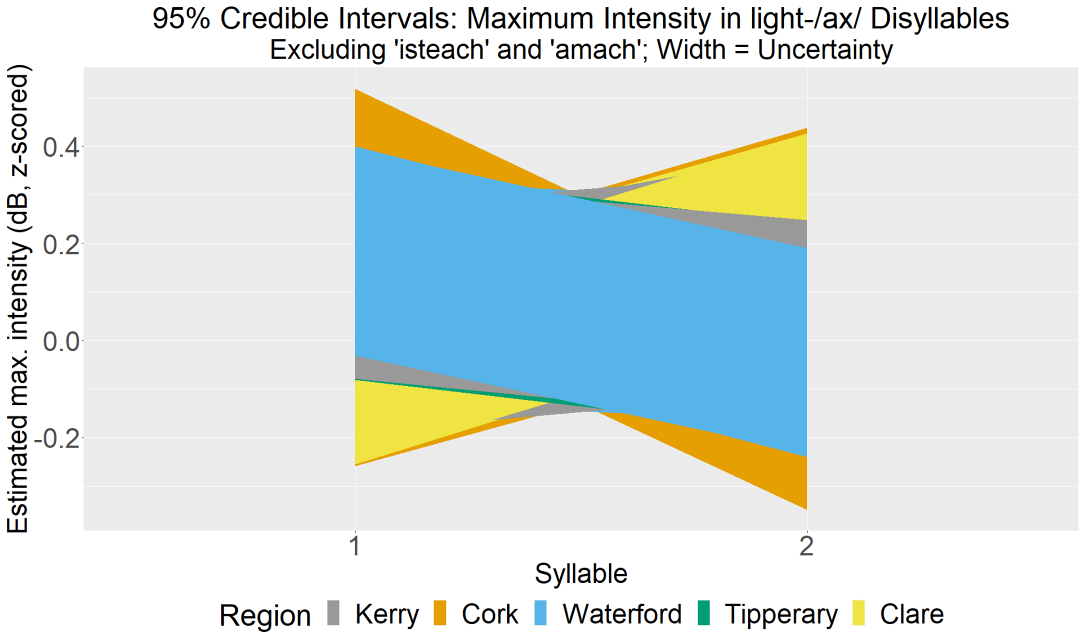

Figure 38 *95% credible intervals for light-/ax/ disyllables from Model 1b (maximum intensity in 1928 disyllables, excluding high-frequency* isteach *and* amach *from the data). There is a divide between speakers with decreasing versus increasing intensity between syllables in these items.*

The outsized influence of *amach* and *isteach* on the joint posterior distribution of the model is immediately evident, as the apparently neat intensity increase from initial to final position disappears. Concurrent with this exclusion's elimination of roughly half of LX observations in the data, 95% credible intervals for LX items in Model 1b are approximately twice as wide, with a range of approximately 0.4z instead of the 0.2z of the unrestricted Model 1.

A cross-syllable increase in intensity is certainly still evident for all Clare and some Cork and Kerry speakers, but there are now substantial predictions of cross-syllable *decrease* in intensity for LX disyllables for speakers from Waterford, Tipperary, and the remaining Cork and Kerry speakers. At the very least, this indicates that intensity-prominence does not necessarily occur non-initially for light-/ax/ tokens as a matter of course. This illustration of individual lexical items' and lexical subcategories' impact on impressions of apparently weight-sensitive prominence implementation highlights the relevance of examining prominence independent of etymology and metalinguistic knowledge. The nonword production experiment discussed in Chapter 6 attempts to do exactly this.

The remaining shift-eligible categories (HH, LH, XH, and XX) do not neatly square with intensity-prominence being assigned to a final heavy (or /ax/) syllable of a disyllabic word. Estimates for HH and XX show either minimal change across syllables (especially for Clare speakers) or declination from initial to final position.

For LH, 95% credible intervals are relatively tightly constrained, but exhibit the full range of variation from cross-syllable declinations to even intensity maxima in each syllable to cross-syllable increases. With some exceptions, there is intraregional consistency in estimated values: Cork, Waterford, and Tipperary speakers by and large have declination (i.e. higher intensity maxima on initial syllables) or no appreciable change predicted, while Kerry and Clare speakers consistently show estimated increases (i.e. higher intensity maxima on final syllables). It is also worth noting that estimated changes for this category are very modest compared to, e.g., the steeper change seen between initial and final syllables for HL items. For XH, similar variability and apparent regional clustering is evident, but with far wider credible intervals. This is consistent with the smaller amount of data available for this category versus for LH.

Insofar as the results of Model 1 are reliable, the above suggest in regard to RQ2 that maximum intensity in disyllables for 1928 speakers does not align with predictions of prominence occurring on final heavy or /ax/ syllables. Further, variation across subregions is evident; this begins to address RQ4 concerning prosodic uniformity in Munster. Recall that this is of particular interest, given the tendency in formal phonological literature to discuss a monolithic ‘Munster’ PLP system. Over the course of Models 2-16, further evidence is accumulated regarding RQ2/a along with RQ2b concerning change between 1928 and 2020-21. Discussion proceeds with maximum intensity in 1928 trisyllables below.

Model 2: Intensity in 1928 trisyllables

Model 2 was specified in line with Model 1, with the exception of the previously described replacement of a single treatment-coded independent variable of second-syllable position with two such variables representing initial and final position. The model’s satisfactory convergence is evident in the posterior predictive check presented in Figure 39, where the uneven distribution of the data across 18 trisyllabic weight structures can also be seen. Four structures (HHH, HXX, XLL, and XLX) were attested by only a single token each in the 1928 data, and a further three (HLX, HXL, and LXH) had three or fewer. The consequences of sparse attestation emerge in the model results.

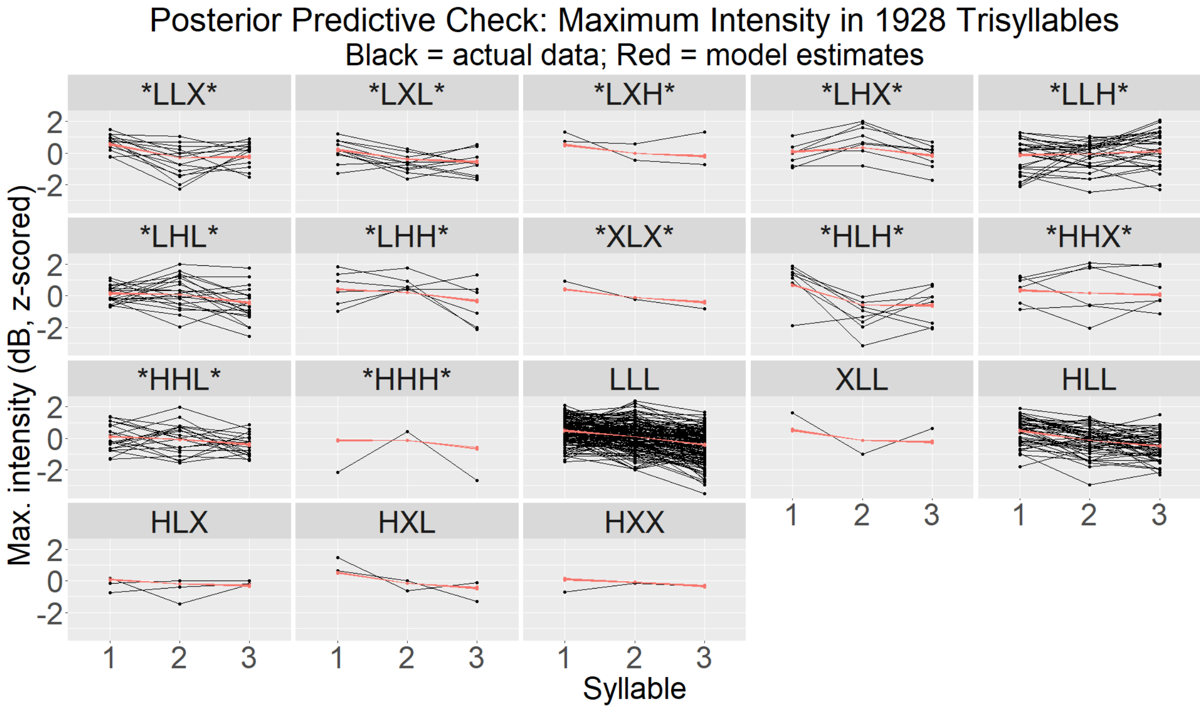

Figure 39 *Posterior predictive check for Model 2 (maximum intensity in trisyllables), showing satisfactory model performance.*

Turning to by-weight 95% credible intervals in Figure 40, there is greater cross-regional correspondence in predictions for trisyllables than in disyllables of the same era, but this is accompanied by a great deal of uncertainty in the majority of categories. Given the relatively sparse attestation of the majority of trisyllabic weight structures, this uncertainty in model estimation comes as no surprise. CIs are narrowest for the more heavily evidenced LLL, HLL, and LLH, and HHL.

PLP is uncontroversially predicted to occur in initial position for the following trisyllabic weight structures: HLL, HLX, HXL, HXX, LLL, and XLL. In these structures, the heaviest syllable either occupies the initial position, or all syllables are light. Model predictions broadly correspond to this prediction: intensity maxima are predicted to be highest in the initial syllable for HLL, HXL, LLL, and XLL, although the latter is based on only a single observation. Estimates for HLX are ambiguous insofar as they are roughly even across all three syllables.

Amongst categories hypothetically eligible for PLP-shift, only for LHX is non-initial intensity-prominence predicted with any consistency. Four out of seven of the observed lexical items for this category are instances of *amá*(*i*)*r*(*e*)*ach* ‘tomorrow’ – another case of lexically-specific non-initial PLP consistent across all varieties of Irish. For the remaining shift-eligible weight structures (HHH, HHL, HHX, HLH, LHH, LHL, LLH, LLX, LXH, LXL, and XLX), intensity maxima are predicted to either roughly decrease over the course of the three syllables, or to remain constant.

Especially in the context of so many wide credible intervals, the ‘trends’ discussed above must come with the general disclaimer that within each credible range of predictions for each syllable, region, and speaker, a great number of patterns are credible as the ‘real’ values of standardised intensity across trisyllabic words.

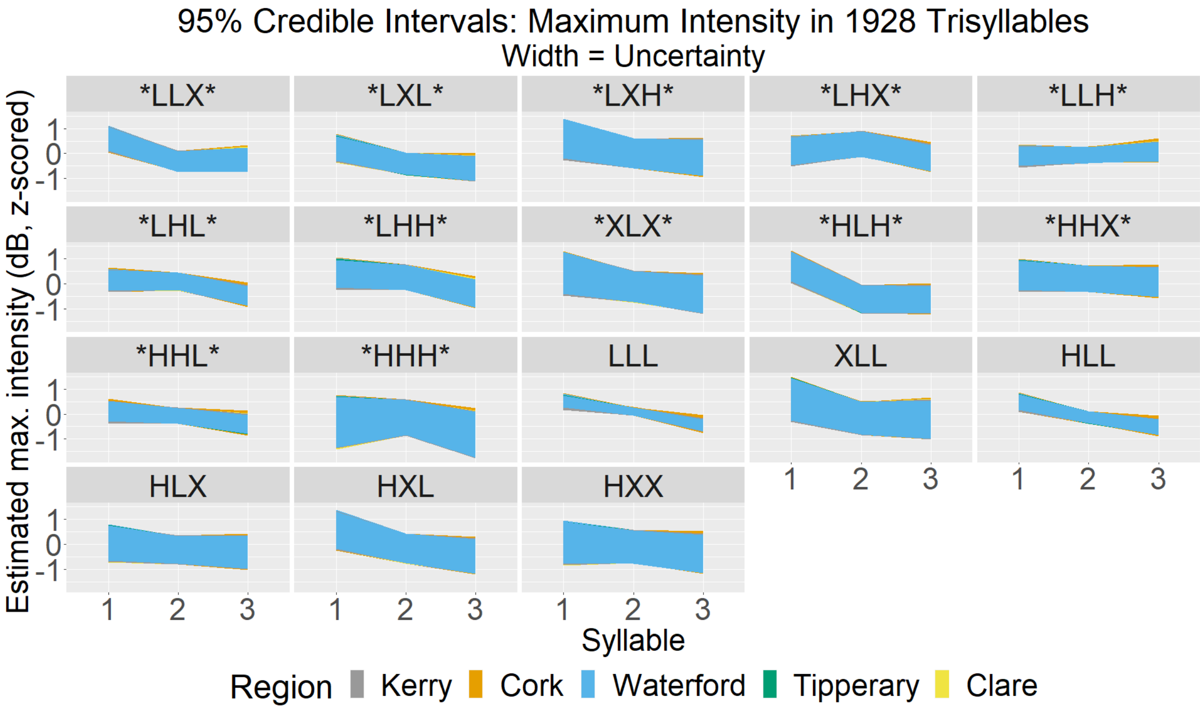

Figure 40 *95% credible intervals from Model 2 for maximum intensity in 1928 trisyllables, with medial position (Syllable 2) representing the intercept and other syllable values estimated as changes from said intercept. Wider bands indicate greater uncertainty in the model’s estimates.*

In a sense, it is easier and more reliable to say what inferences the model does *not* credibly support than to enumerate those that it does. Under this approach, it is clear that this model does not provide evidence of non-light syllables in medial and final position robustly attracting intensity prominence, nor that the syllable /ax/ acts ‘heavier’ than other syllables containing short vowels for the same purpose. This is another mark against RQ2. Regarding RQ2a, however, results for intensity in 1928 trisyllables show consistency across regions (even if this is only consistency in flat/uninformative estimates with high uncertainty). Models 3-4 below now introduce models of the present-day 2020-21 data, allowing us to begin addressing RQ2b in addition to RQ2/a.

Model 3: Intensity in modern (2020-21) disyllables

Model 3 of maximum intensity in disyllables from the 2020-21 data directly parallels the structure of Model 1. A posterior predictive check indicating satisfactory convergence is presented in Figure 41.

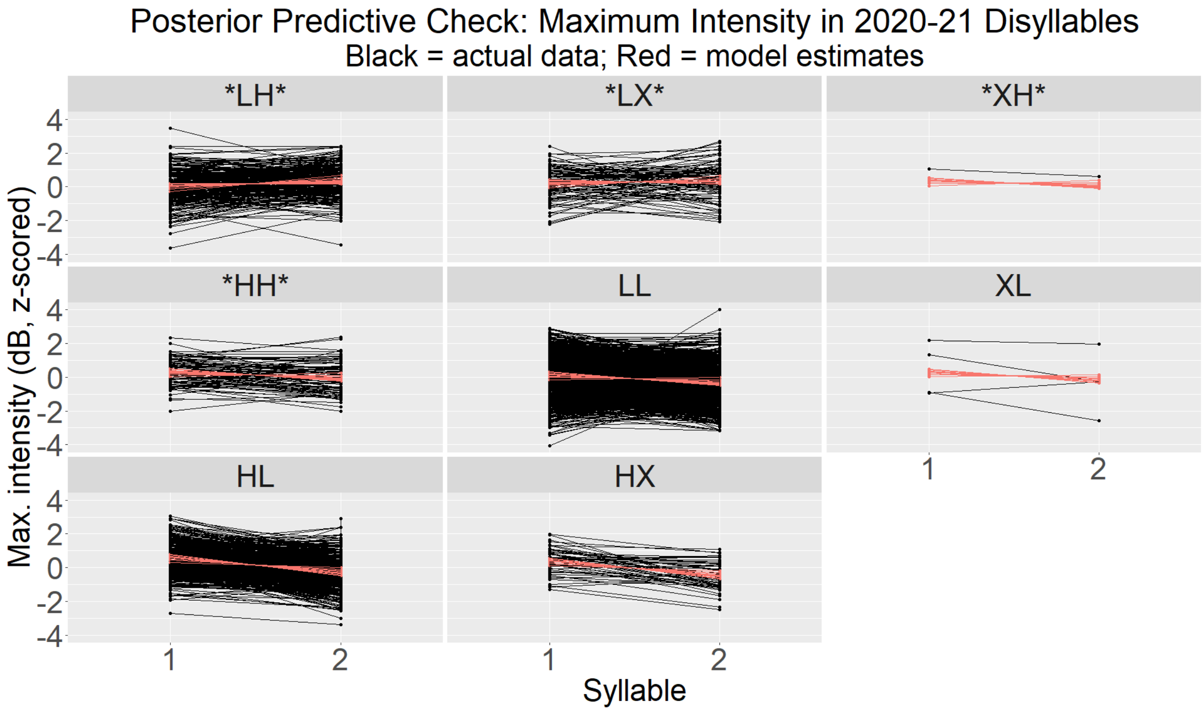

Figure 41 *Prior predictive check for Model 3 (maximum intensity in 2020-21 disyllables), indicating satisfactory model performance. Sparseness of /ax/-heavy and /ax/-light items is evident, and /ax/-/ax/ is not attested in the data at all.*

Turning to the 95% CIs across regions and weight structures in Figure 42, a number of interesting divergences from the previous century's patterns emerge. For weight-structure categories with uncontroversial initial PLP – HL, HX, LL, and XL – the picture is broadly in line with that seen for the 1928 Doegen data; intensity prominence is predicted to occur in initial position with relatively narrow 95% credible intervals. The only exception to this is XL, predictions for which show apparent regional differentiation. However, given the broad uncertainty deriving from the paucity of datapoints available in the modern data for this structure, this is not particularly informative.

The XL category is only represented by single tokens of four lexical items produced by one speaker from each region. As such, it is clear that the uncertainty itself is driven by the lack of data, and the apparent regional differentiation is based on technical, and very possibly coincidental, regional diversity across the paltry four tokens available. For all four items (*buachaill* 'boy', *rachmas* 'abundance', *rachaidh* 'will go', and *seachas* 'except, rather'), PLP is very definitely fixed in initial position in Munster, as well as in other varieties of Irish. The contextual occurrence of higher intensity in final position is far more compatible with phrase-level prosodic considerations than with a change in the location of phonological prominence and this phonetic exponent of the same.

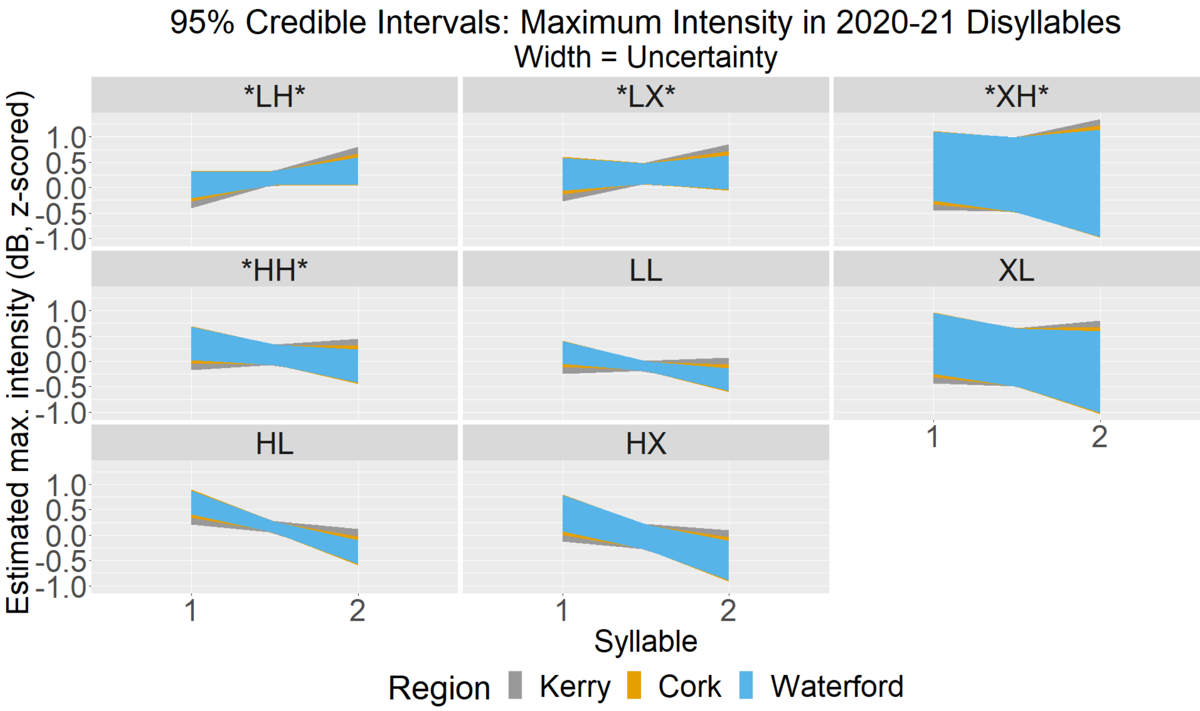

Figure 42 *95% credible intervals by weight structure from Model 3 (maximum intensity in 2020-21 disyllables).*

For shift-eligible categories HH, LH, LX, and XH, model predictions range from correspondence to the 1928 model to noteworthy divergence. LH words are the only ones consistently predicted to have higher intensity in second syllables across the board, albeit somewhat weakly for Waterford speakers, some of whom are predicted to have relatively flat intensity across the two syllables.

Modern Kerry speakers are consistently predicted on the basis of the available data to have higher intensity in the second syllable of HH words (led in frequency by *cónaí* ‘home’, *tabharfaí* ‘would be given’, and *dhiúlthaíos* ‘I refused’) in line with the typical Munster PLP-shift model, but this is not the case for the Cork and Waterford speakers. Predictions for Cork speakers range from flat to slight declination, and Waterford speakers are fairly robustly predicted to exhibit an intensity decline from initial to final position.

For LX, the majority of Kerry and Cork predictions show increases in maximum intensity from initial to final position, while Waterford speakers are once again split between slight declines and slight increases. Here it is once again useful to eliminate the heavily represented and prosodically anomalous items *amach* and *isteach* and remodel (Model 3b). The new CIs resulting for the LX category are presented in Figure 43.

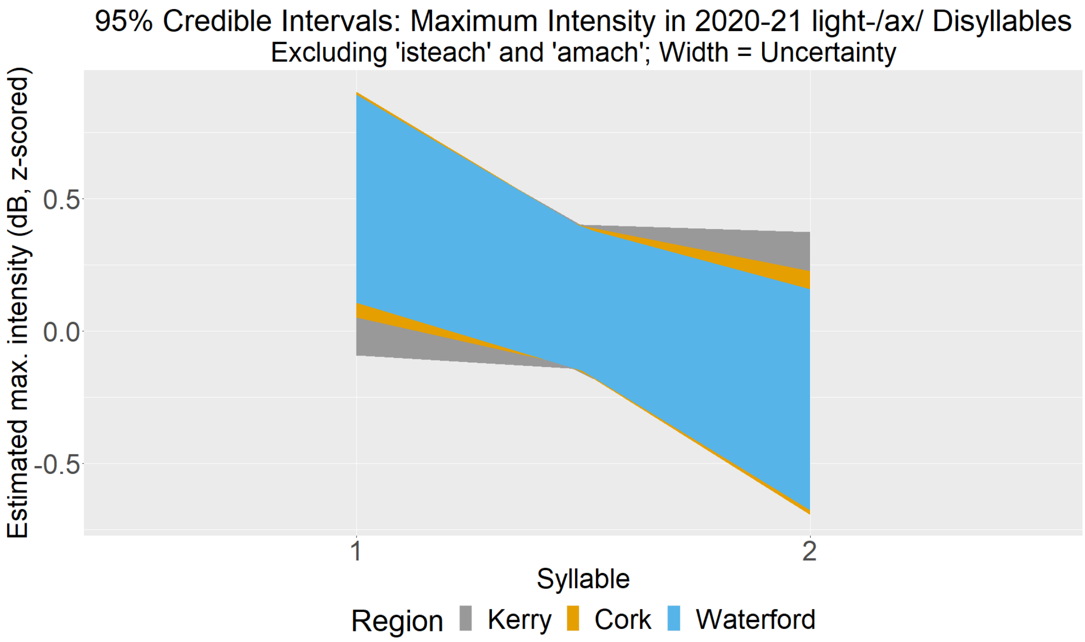

Figure 43 *95% credible intervals for light-/ax/ disyllables from Model 3b (maximum intensity in 2020-21 disyllables, excluding high-frequency* isteach *and* amach *from the data).*

Model 3b's predictions for the restricted LX data show greater uncertainty due to the number of available tokens being halved, with credible intervals now spanning approximately 0.6z instead of the ~0.3 shown by the category in the original Model 3. However, the direction of predictions for cross-syllable change in intensity maxima are now in line with initial intensity-prominence than final. This is categorically the case for Cork and Waterford speakers' predictions; within the evident range of credible real values for these two groups, all predictions are negative or, at the most, flat. For Kerry speakers, predictions' credible intervals appear flat across the board. Within these wide, flat intervals, modest increases in maximum intensity from initial to final position are credible, alongside modest decreases or a lack of appreciable change in intensity levels.

This does not square neatly with /ax/-syllables as medium-heavy able to productively attract PLP away from an initial light syllable, particularly when compared to the clear predictions of final intensity-prominence for LH disyllables such as *deartháir* 'brother' and *arán* 'bread'. Further, this is in contrast to the results of restricted-LX remodelling for the 1928 Doegen data in Model 1b, in which a substantial number of predictions for Kerry, Cork, and Clare indeed *do* suggest strong intensity increases in second syllables for LX items excluding *isteach* and *amach*.

Finally, for XH targets, uncertainty is so great as a result of the model being supplied with only a single data point that the estimations do not warrant much attention. In fact, the latter are effectively maximally uninformative and can be seen to rely almost entirely on the model priors (i.e. a normal distribution for all parameters with mean 0 and standard deviation 1): predictions for final syllables are 2z wide.

To summarise, for weight structures with uncontroversial initial PLP, model predictions based on modern data correspond to model predictions for equivalent 1928 data in terms of change in syllable intensity maxima over disyllables. For categories which are purportedly subject to weight-driven movement of PLP to non-initial position, however, there is more variability between results for the two generations. 2020-21 LH items show estimated cross-syllable increases versus predicted unchanged intensity maxima for the 1928 data. By contrast, cases such as HH show a change from clearly predicted cross-syllable decreases for 1928 data to a more ambiguous state of affairs in the present day (including the possibility of pronounced intensity prominence in final position). The opposite can be said for LX cases (excluding deuterotonic adverbs *isteach* and *amach*): regional and speaker splits between predicted and increases and decreases for 1928 data have apparently changed to predicted cross-syllable decreases in intensity for present-day speakers.

As such, regarding RQ2/a, it is clear that intensity in modern disyllables does not always align with descriptions of non-initial PLP location (RQ2). Cross-regional uniformity is more evident than in the model of intensity in 1928 disyllables, but is still broken by some categories such as HH (RQ2a). Finally, results of Models 1 and 3 for equivalent data from 1928 and 2020-21 can be seen to differ from one another, although such change for distribution of intensity prominence does not clearly move towards or away from received descriptions of PLP location (RQ2b). The final real-word intensity model below considers modern trisyllables for comparison with Model 2.

Model 4: Intensity in modern (2020-21) trisyllables

This model looks at change in maximum syllable intensity for trisyllables in the 2020-21 data, paralleling Model 2 of the 1928 data. The model converged without error, as illustrated in Figure 44.

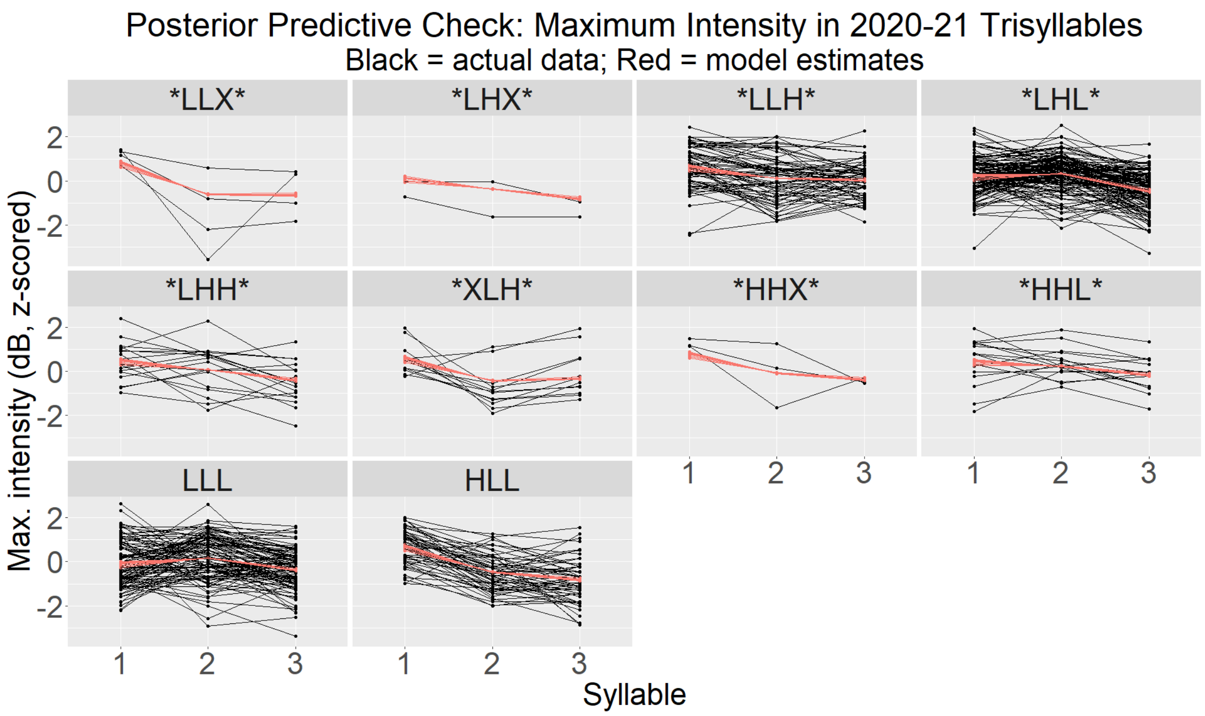

Figure 44 *Prior predictive check for Model 4 (maximum intensity in 2020-21 trisyllables). Uneven distribution of the data across weight-structure categories is evident.*

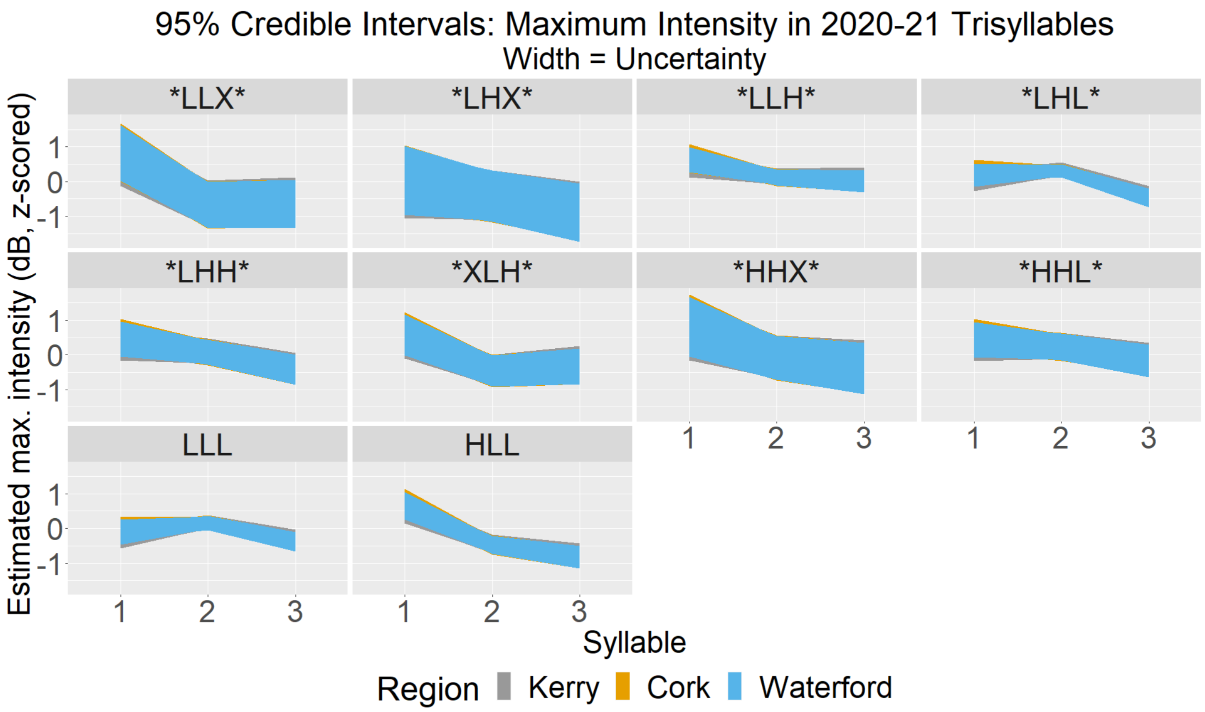

Figure 45 *95% credible intervals by weight structure for Model 4 (maximum intensity in 2020-21 trisyllables).*

95% credible intervals for intensity maxima by weight structure are presented in Figure 45. Regarding RQ2a, model results appear to be uniform across region groups. As for the 1928 Doegen data, the picture for intensity prominence in trisyllables is somewhat more complicated than that for disyllables, not least because of the larger number of categories to consider. The task of comparison across era groups is further complicated by the very uneven distribution of tokens for each weight structure both within and across groups. Nevertheless, some general observations can be made.

Turning first to uncontroversially initial-PLP categories, predictions for all-light LLL immediately leap out as unusual: the model predicts higher intensity maxima in medial position rather than initial. This is in contrast to the initial intensity-prominence predicted on the basis of the 1928 data in Model 2. The most frequent LLL target in both eras, as seen in Table 9 (Section 5.1), is *abhaile* '(at/to) home', which – like disyllabic *amach* and *isteach* – universally exhibits medial PLP in all varieties of Irish due to the initial syllable's derivation from a non-PLP particle. In the 1928 data, *abhaile* is roughly twice as frequent as the next item (*airgead*). In the 2020-21 data, however, tokens of *abhaile* outnumber the next most frequent item (*uireasa*) four to one. Given this more pronounced overrepresentation, it is not surprising to find that *abhaile*'s idiosyncratic prominence pattern should influence the outcome of this model.

As for LX disyllables in Models 1b and 3b, it is useful to exclude this exceptional high-frequency target in order to compare model estimates for intensity prominence across LLL items without its influence. The exclusion of *abhaile* tokens for Model 4b immediately brings predictions for LLL words in line with overall initial-syllable prominence: a clear decline in intensity maxima height is predicted over the course of LLL words, as shown in Figure 46.

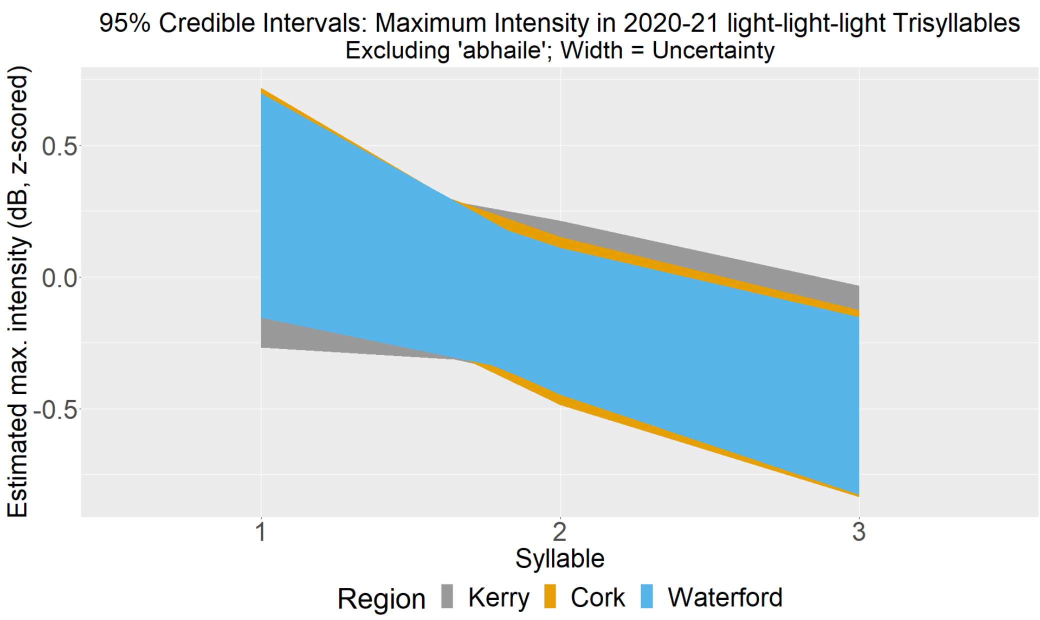

Figure 46 *95% credible intervals for light-light-light trisyllables from Model 4b (maximum intensity in 2020-21 trisyllables, excluding high-frequency light-light-light* abhaile *from the data). Marginal medial intensity-prominence for this category seen in Model 4 (Figure 43) disappears in the absence of* abhaile*'s outsized influence. Initial prominence is now estimated.*

For the other uncontroversially initial-PLP weight structure HLL (dominated by *láthairse* ‘place[.EMPHATIC]’ and *laethanta* ‘days’), model predictions for intensity-prominence robustly reflect the expected strength of the initial syllable. All speakers from all regions are predicted to have notably higher intensity maxima on the initial heavy syllable than on either of the two light syllables following. Like clear intensity decreases across HL disyllables in Models 1-2, this is satisfying as a basic health-check with regards to model predictions’ alignment with basic assumptions about PLP and intensity prominence in Irish.

Amongst potentially shift-eligible weight structures, as for Model 2 of 1928 data, only LHL is predicted to have anything approaching consistent medial intensity-prominence, although a plateau extending from the initial syllable is also credibly possible (i.e. equivalent intensity maxima across the first two syllables). This category is led in frequency by *ceiliúradh* ‘celebrating, celebration’, *s*(*h*)*eirbhísigh* ‘servants’, and *s*(*h*)*ealúchas* ‘inheritance’.

The remaining shift-eligible categories HHL, HHX, LHH, LHX, LLX, LLH, and XLH all show broadly predicted initial intensity-prominence in combination with fairly wide credible intervals. These are broadly parallel to predictions for the same categories in the 1928 data, with the exception of LLH, for which initial intensity-prominence is more robustly predicted for present-day speakers than for 1928 ones (for whom Model 2 showed a weak prediction of final intensity-prominence). This adds further support to the hypothesis proposed for RQ2, namely that phonetic measures of prominence would not align with described PLP location – although non-intensity measures in Models 5-16 are yet to be examined.

Interestingly, the LLH results run counter to my hypothesis for RQ2b that more conservative archival data would show *less* evidence of PLP-shift (particularly for intensity than for more conceivably phrasally/contextually-conditioned pitch measurements), by contrast to modern speakers having a more consolidated pattern in line with that typically described for Munster. To this must be added two caveats, however. First, the RQ2b hypothesis refers to prominence in multiple parameters, and so far we have only examined intensity. Second, the apparent era difference for LLH items may relate to lexical representation: the modern data for this weight structure are led in frequency by the plural imperative verbs *cuirigí* ‘put’ and *beirigí* ‘take’, while 1928 ones are led by nouns *dheartháir* ‘brother’ and *feirmeoir* ‘farmer’ (both with epenthetic medial schwas not reflected in the orthography, and at variance with common disyllabic alternatives lacking such epenthesis). As a restriction on PLP shifting being caused by heavy verb terminations such as those of *cuiri**gí*** and *beiri**gí*** has been previously proposed in the literature (i.e. verbal forms such as these not being eligible for final PLP), a case could be made that this initial versus final intensity prominence is a reflection of that, rather than of diachronic change. In any case, the predicted LLH intensity-prominence patterns for both era groups are fairly modest, and the blindness of the model to prosodic context adds another important layer of uncertainty.

Summary of maximum intensity models

To summarise Models 1-4, while intensity prominence (as measured by maximum syllable intensity, standardised by speaker) does sometimes align with right-shifted PLP predicted for Munster, correspondence between previous descriptions and model results is by no means perfect. In fact, amongst disyllables it is only for 2020-21 LH items that expected shifted intensity prominence is predicted to occur. For trisyllables, only 1928 LHX and 2020-21 LHL show intensity prominence on the predicted-PLP medial syllable. Models 1-4 therefore show substantial variance between described PLP location and systematically analysed intensity – a partial negative answer to RQ2, dependent on equivalent analyses of F0 and duration in Sections 5.2.2-5.2.4. Further, variability is evident for model results across regions, particularly for disyllables (Models 1 and 3), in line with the hypothesis proposed for RQ2a.

Finally, results for certain categories, in particular disyllable LX in both eras and trisyllable LLL in the modern data, show evidence of being heavily influenced by specific lexical items (namely *isteach* and *amach* for LX, and *abhaile* for modern LLL). The potential for high-frequency lexical items to influence statistical models of positional distribution of phonetic prominence should be borne in mind as the discussion proceeds through the three other measures below, and indeed more generally for possible lexical biases in the original description of right-shifted PLP in Munster/southern Irish varieties. This contributes to the framing of RQ2c regarding productivity of PLP assignment in Munster, addressed using nonword production data in Chapter 6.

5.2.2 Maximum F0 across syllable positions

Models 5-8 of maximum syllable F0 – converted to semitones with reference to 50 Hz and z-scored by speaker – described in this section, were carried out with identical specifications to those for maximum intensity. For both era-groups, standard deviation of pitch maxima across di- and trisyllables ranged across speakers from approximately 1.5 to 4 semitones. Model results in terms of *z* (speaker standard deviations) should therefore be interpreted at this scale. For example, a change of +0.5z in F0 maximum between two syllables is equivalent to +0.75 semitones for a speaker with a standard deviation of 1.5, but to +2 semitones for a speaker with a standard deviation of 4.

At the outset of this discussion, it is also worth noting that increased F0 height is not inherently equivalent to a phonological tonal target in connection with a given syllable, and further that high F0 and abstract ‘prominence’ do not automatically equate. Additionally, while these models compare syllables’ F0 height, another important piece of F0 information – namely range – is dealt with in Models 9 to 12. The relationship between increased pitch height and metrical strength and/or PLP is returned to in exploration of intonation patterns in these same data in Chapter 7 below.

Results for modelling of maximum syllable F0 across the two syllable-counts and era-groups are very distinct from those for Models 1-4 of maximum intensity, as will shortly become evident. In general terms, evidence of distinct behaviour of intensity- and pitch-prominence is reminiscent of Windsor *et al*.’s (2018) findings with regard to coordination of phonetic exponents of lexical- and phrasal prominence in Munster versus Connemara varieties of Irish. Discussion of Models 5-8 below proceed in the same order as Models 1-4: results for 1928 di- and trisyllables are presented first, followed by results for di- and trisyllables in the present-day (2020-21) recordings.

Model 5: F0 height in 1928 disyllables

This model of F0 maxima in disyllables from the 1928 storytelling data converged without error. Results of a posterior predictive check are displayed in Figure 47, indicating satisfactory performance with respect to predicting values for attested datapoints in line with their actual F0 maxima.

Turning to Figure 48, the primary difference across weight-structure categories is one of relative uncertainty, which is transparently a function of the amount of data available for a given category. There is clear stratification of model results across two regional sub-groupings, paired with remarkable consistency in F0 height estimations within regions. Relative invariance of F0 maxima across weight structures, in contrast to heterogeneity for intensity may indicate that the latter is a better diagnostic for lexical-level prominence (i.e. PLP); this is returned to in summary discussion in Section 5.3 and Chapter 8.

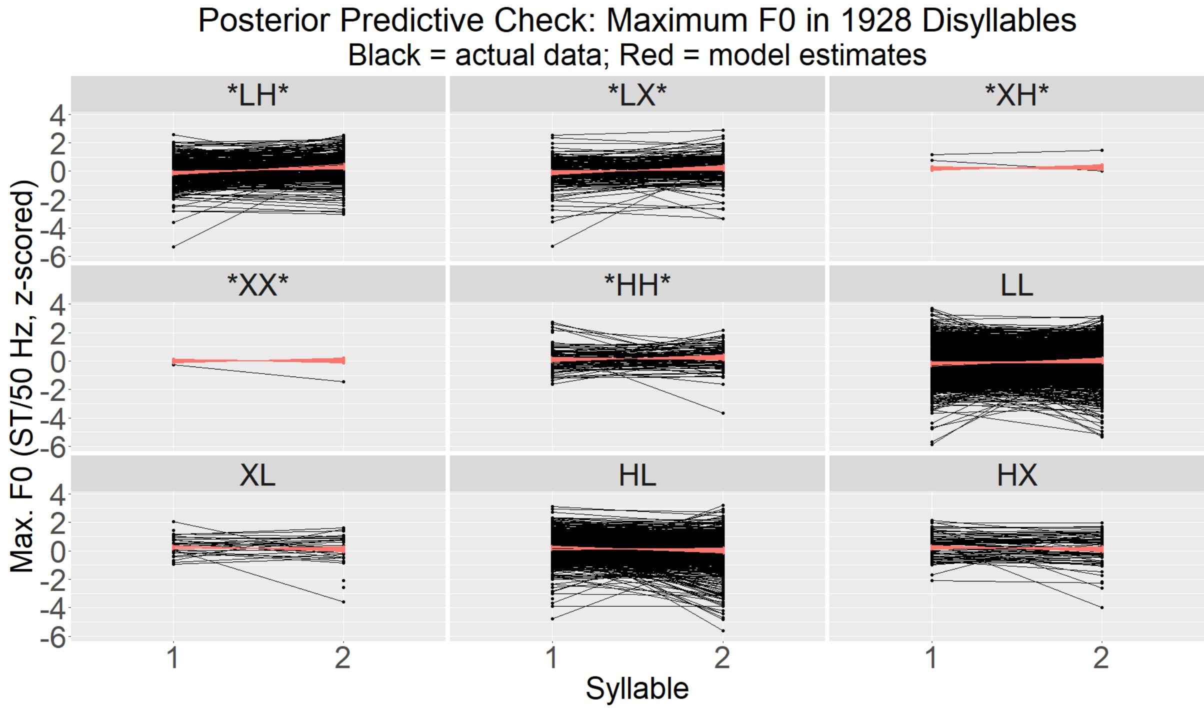

Figure 47 *Prior predictive check for Model 5 (maximum F0 in 1928 disyllables).*

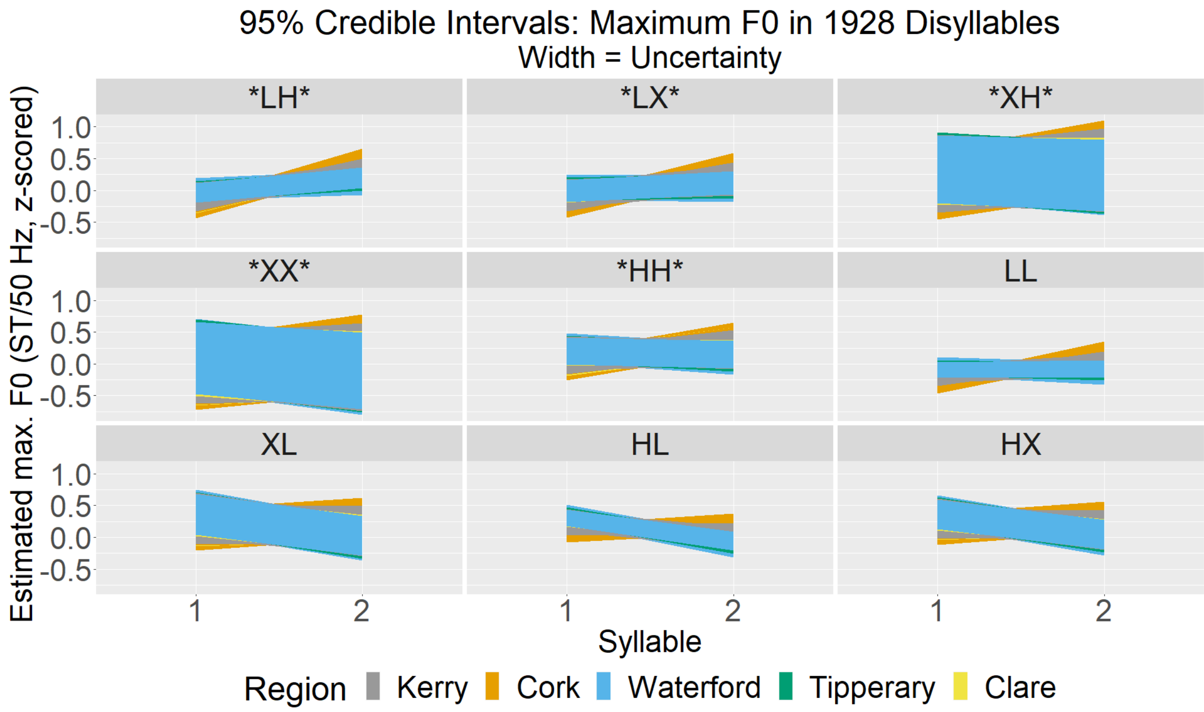

Figure 48 *95% credible intervals by weight structure from Model 5 (maximum F0 in 1928 disyllables).*

For seven of nine categories, Waterford, Tipperary, Clare, and some Cork speakers (the latter two obscured in the figure, but patterning together nonetheless) are predicted to have higher F0 maxima in initial position, whereas Cork and Kerry speakers receive the opposite prediction (higher F0 maxima in final syllables) for all nine disyllable weight structures. For Waterford, Tipperary, and

Clare, estimates for F0 maxima are virtually identical to those for intensity maxima in the same disyllables, in contrast to an apparent split between behaviour of intensity and F0 in Cork and Kerry. For prototypically shift-eligible LH, and LX items, Waterford, Tipperary, and Clare estimates differ from those for the other seven categories. Although not as extreme as the increase predictions for Cork and Kerry speakers, F0 maxima are estimated to be level across the two syllables.

For LX items, the outsized effect of *isteach* and *amach* on model results for intensity maxima in Models 1 and 3 comes to mind. On the basis of the generic cross-syllable increase in F0 maxima for Cork and Kerry speakers, my prediction before remodelling was that the result from using LX data without these two deuterotonic adverbs would yield a change in predicted directionality for those Waterford, Tipperary, and Clare speakers who exhibited a shift in intensity predictions for the restricted data in Model 1b. Results were expected to be unchanged for Cork and Kerry speakers with category-insensitive cross-syllable increases in F0. This Cork and Kerry prediction emerges in Model 5b, the LX predictions for which are presented in Figure 49, but results are equally unchanged for the other speakers/regions. Waterford, Tipperary, most Clare, and some Cork speakers show flat estimated F0 maxima between initial and final syllables, in contrast to intensity results for the same restricted dataset in Model 1b (Figure 38), which showed clear increases and decreases in prominence between syllables.

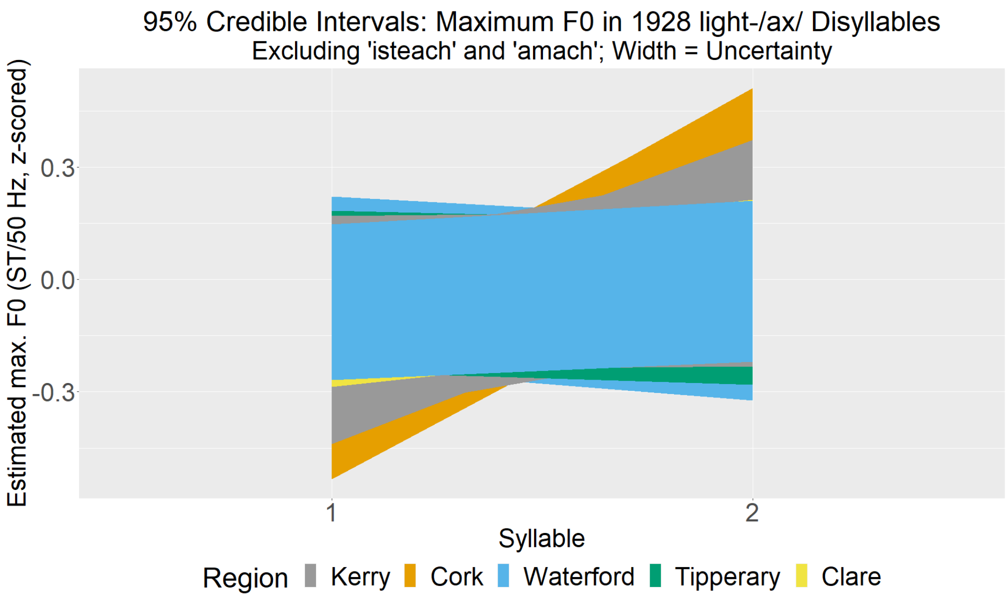

Figure 49 *95% credible intervals for light-/ax/ disyllables in Model 5b (maximum F0 in 1928 disyllables, excluding high-frequency light-/ax/ items* isteach *and* amach*). Model estimates are unchanged from the original Model 5 (Figure 47).*

Regarding Model 5 results for LL items in Waterford, Tipperary, and Clare, the lack of predicted change in F0 maxima between syllables is not surprising, even given expected initial PLP in these items. By far the most common word evidenced in this category is *agus* 'and', which is unlikely to receive intonational marking. Recall that for intensity maxima in Model 1, this *agus*-heavy category was predicted to either exhibit the expected cross-syllable decline in prominence, or else to have flat, average values.

In summary, model results for F0 maxima in 1928 disyllables diverge considerably from those for intensity maxima (Model 1). Cork and Kerry speakers are estimated to have a generic increase in maximum F0 in final syllables, regardless of weight structure, while Waterford, Tipperary, and Clare speakers present moderate evidence of F0 height changes more in line with those seen for intensity. This combined pitch and intensity increase in final syllables roughly aligns with predicted right-shifted PLP. F0 results do not contradict that for these speakers, but do not indicate a consistent change in F0 maxima associated with final syllables in shift-eligible LH, LX. Cumulative phonetic evidence for and against PLP shift is returned to in Section 5.3; for the moment, these results contribute to the answering of RQ2 insofar as it shows divergence between the two prominence measures modelled up to this point, and RQ2a in starkly demonstrating variability between different Munster subregions.

To the latter point, the patterning of western Clare with the eastern Déise varieties (in most cases) is of interest. I hypothesise – tentatively – that the Kerry/Cork pattern of late-aligned high pitch regardless of weight structure is the more conservative. In support of this, consider the highly weakened contemporary state of the now-extinct Clare and Tipperary varieties, and the diminishing state of Waterford Irish before being stabilised in the two villages of the modern Waterford Gaeltacht by the establishment of a local Irish-language college in 1906. It does not seem an implausible leap to suggest greater influence of English-type prosody in speakers of these numerically weaker varieties at the time of recording in 1928.

By comparison, although the situation has changed drastically over the last century, in the 1920s, both the Kerry and Cork Gaeltachtaí were of robust vitality. Perhaps most strikingly, monolingual Irish speakers – admittedly in a vanishing minority – were still to be found in both subregions, with the Kerry data including two such monolinguals (SÓC and MMG), neither of whom had any formal education nor had ever spent substantial time outside their native locales. This line of reasoning is returned to in light of findings for regional and diachronic alignment of high F0 and intensity prominence in Chapter 7.

Model 6: F0 height in 1928 trisyllables

This model used the same structure as Models 2 and 4 (intensity in trisyllables). The model converged without error, as illustrated with the prior predictive check shown in Figure 50. Before discussing model predictions for trisyllables in the 1928 data, it is important to recall the paucity of data available for the majority of the 18 possible weight structures. Remember that in these cases, the model relies heavily on the minimally informative, though helpfully regularising, priors in order to converge; expectations of model results' predictive and inferential utility should therefore be adjusted accordingly. As mentioned in treatment of Model 2 and evident in the frequency distribution shown in Section 5.1, the most data on trisyllables for this era are available for the LLL category, followed by HLL, and more distantly by shift-eligible HHL, LLH, and LHL. With this in mind, by-structure 95% credible intervals from this model are presented in Figure 51.

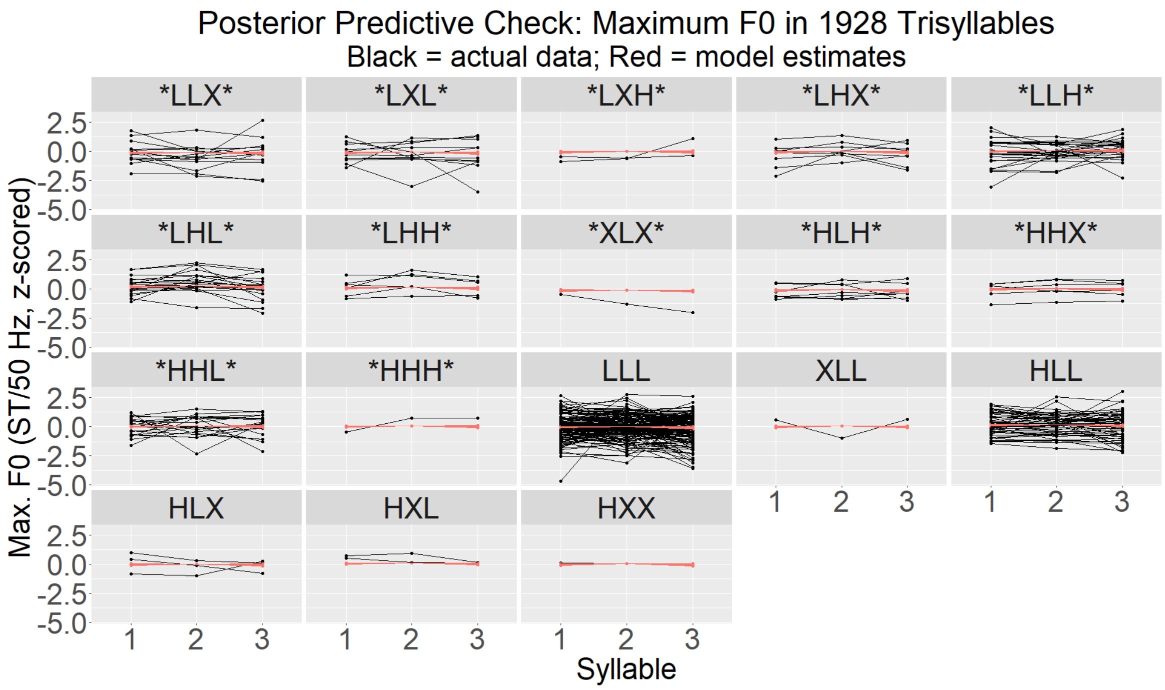

Figure 50 *Prior predictive check for Model 6 (maximum F0 in 1928 trisyllables).*

In general, model predictions for behaviour of F0 maxima across positions in 1928 trisyllables stand very much in contrast to those for maximum syllable intensity (Model 2), despite the two models utilising the same data and very similar, regularising priors. Even for more sparsely attested categories such as LHH, LLX, or LHX, the intensity model was able to make category-specific predictions with reasonable credibility. This may indicate more consistent intensity values across limited observations, in contrast to variability in F0 height which may hamper pattern extrapolation.

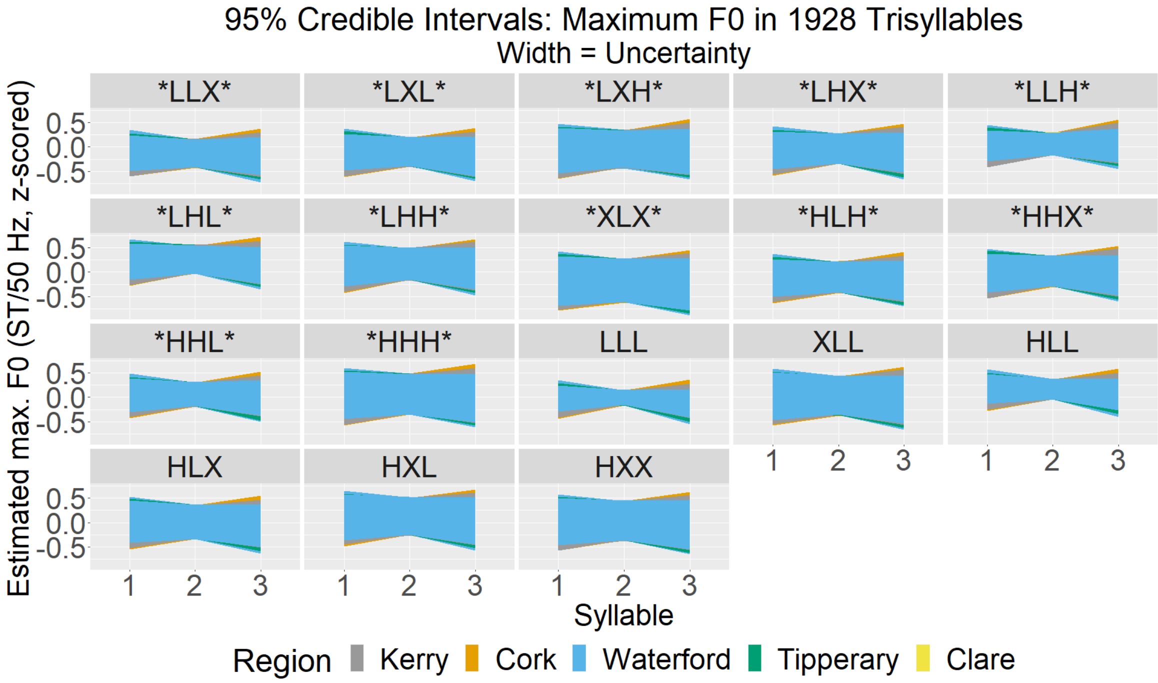

Figure 51 *95% credible intervals by weight structure from Model 6 (maximum F0 in 1928 trisyllables).*

Speakers appear to have relatively fixed default patterns of pitch height over the course of trisyllabic words – regardless of (i) weight structure and (ii) predicted location of intensity-prominence in a given category – although predictions for what this default pattern is vary speaker-to-speaker (not pictured in Figure 50) and, more robustly, region-to-region. The latter shows the same broad grouping seen for disyllables in Model 5, with a general split between Cork/Kerry and Waterford/Tipperary/Clare. Cork and Kerry speakers are predicted to have a gradual increase in F0 maxima height over the course of the three syllables, while Waterford, Tipperary, and Clare speakers are predicted to show either unchanged cross-syllable height of F0 maxima, or a slight decline (although these estimates are very uncertain).

Additionally, there is a medial 'pinch' in credible interval range visible across all categories in Figure 51, mainly associated with the Waterford, Tipperary, and Clare speakers. This is at least in part a result of medial-syllable values being coded as the intercept for modelling purposes – recall that syllables were treatment-coded as '+/- first syllable' and '+/- third syllable', with two null values (i.e. the intercept for model estimates) indicating a second syllable by elimination. The effect of the initial- and final-syllable factors introduces an additional level of uncertainty into the model, so it is not surprising to see more constrained predictions for reference-level medial position by comparison.

Finally, unlike for intensity maxima in the same trisyllables (Model 2), there is no prediction of medial pitch-prominence for LLL items in this measure, despite the outsized representation of deuterotonic *abhaile* which appeared to drive second-syllable intensity peaks. The situation is no different for the trisyllable structures HHL, LLH, and LHL purportedly eligible for rightward shift of PLP – model results for F0 maxima in trisyllables are not affected by weight structure. This is distinct from a consistent pattern existing at all, but indicates that insufficient evidence exists in the data for the model to extrapolate one.

In summary, Model 6 does not predict robust changes in F0 maxima in line with predicted right-shifted PLP location (insofar as it meaningfully predicts positional change in this parameter at all). This weakly contributes to a negative answer to RQ2 regarding phonetic support for described PLP location in the literature. Further, the same regional subgrouping seen for Model 5, dividing Cork/Kerry from Waterford/Tipperary/Clare, emerged, supporting scepticism for prosodic uniformity in Munster (RQ2a). With Models 7-8 below, RQ2b concerning change between 1928 and 2020-21 can be evaluated with respect to patterning of F0 height.

Model 7: F0 height in present-day (2020-21) disyllables

Model 7 uses identical specifications to Model 5, but is applied to disyllable data from the 2020-21 recordings. Like the preceding models, convergence was achieved without issue and a posterior predictive check (Figure 52) returned acceptable results.

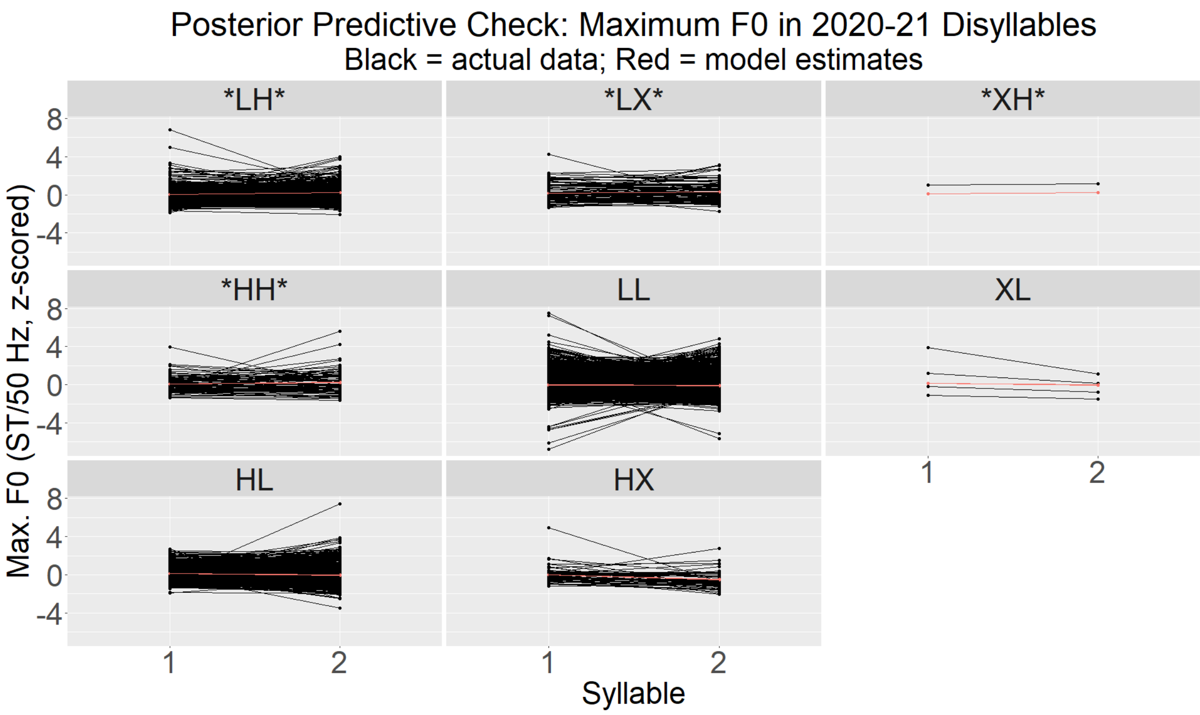

Figure 52 *Prior predictive check for Model 7 (maximum F0 in 2020-21 disyllables).*

The model results in Figure 53 look strikingly different to those seen for F0 height in the 1928 data (Model 5, Figure 48). Before discussion of this, however, note that predicted changes in height of F0 maxima are, in the first place, very modest. Only for HX does the model consistently estimate a cross-syllable change of more than 0.25z. Weight structures XH and XL, are more sparsely attested in the modern data than they are in those for 1928. The highly uninformative predictions for the latter two categories reflect this scarcity. As for 1928 trisyllables, the more restrained nature of predictions for the reference/intercept syllable – initial, in the case of disyllables – is also evident in these two categories. The most striking difference of all is the uniformity of predictions across the three region-groups with varieties that have survived into the 21st century. By and large, predictions for modern Cork and Kerry speakers now align closely with those for 1928 Waterford, Tipperary, and Clare speakers. Waterford predictions remain largely unchanged from 1928.

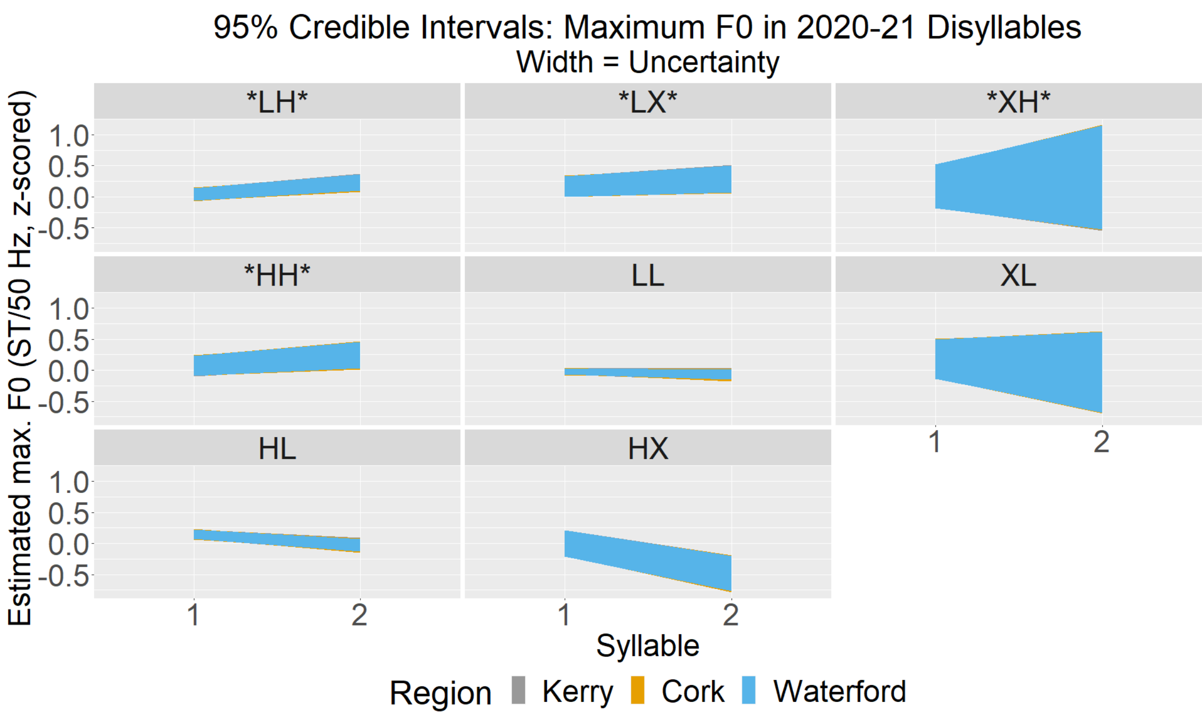

Figure 53 *95% credible intervals by weight structure for Model 7 (maximum F0 in 2020-21 disyllables).*

For uncontroversial initial-PLP structures HL, LL, HX, and XL, F0 maxima are predicted to be either unchanged across syllables, or to exhibit a moderate decrease from initial to final position. This is in line with predictions for syllable intensity-maxima in the same data (Model 3). For shift-eligible structures HH, LH, LX, and XH, there are technically credible predictions of increases in F0 maxima height in final position, but this is on an extremely small scale (e.g. a change of +0.25z is, for the most varied speaker, only 1 semitone). This is largely consistent with findings for intensity in Model 3.

As for Models 1 and 3, this model can be refined to see if results for LX items are consistent when high-frequency *isteach* and *amach* (with exceptional pan-Irish final PLP) are eliminated. Based on the results of the equivalent refinement for Model 3b in Section 5.2.1, and the general correspondence between F0 maxima and intensity predictions for other weight structures in this model, I hypothesised that predictions based on the restricted LX data would show a slight decrease in F0 height from initial to final position. Instead, the outcome of Model 7b (Figure 54) with restricted LX data is effectively unchanged; credible intervals remain wide, allowing for a possible but by no means necessary increase in maximum pitch height from initial to final position in these items. Evidently, variability in F0 height across items of this structure is pronounced enough to prevent meaningful predictions, regardless of *isteach*/*amach*'s inclusion or exclusion.

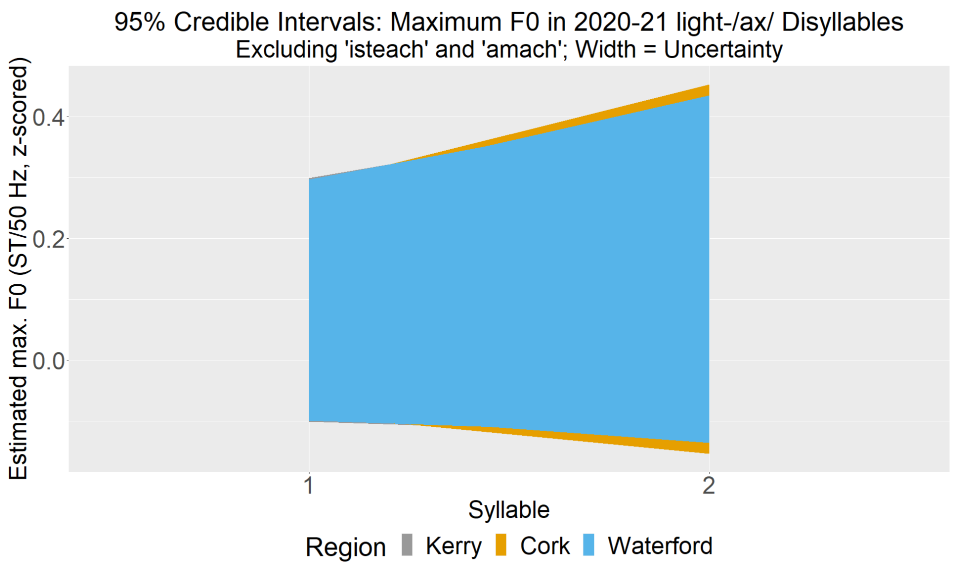

Figure 54 *95% credible intervals for light-/ax/ disyllables in Model 7b (maximum F0 in 2020-21 disyllables, excluding high-frequency light-/ax/ items* isteach *and* amach*). Model estimates are unchanged from the original Model 7, and make no meaningful estimations of change in F0 height between initial and final syllables in this weight structure.*

To summarise, this model is unable to tell us very much about consistent positional changes in F0 height over disyllables. Regarding RQ2, there is little evidence of F0 height predictions aligning with predicted PLP shift in Munster, with the exception of weakly predicted F0 increases in the final syllable of LH items. For the purposes of RQ2a, meanwhile, this model shows cross-regional uniformity in place of the subgroupings seen for the 1928 data in Model 5 consistent with a similar cross-era change seen between Models 1 and 3 for intensity (RQ2b); Kerry and Cork appear to no longer exhibit a consistent second-syllable increase in F0 maxima.

This apparent change in Kerry and Cork predictions between 1928 and the present day is striking. The directionality of this change, towards the pattern previously seen for Waterford/Clare/Tipperary in Model 5 for the 1928 disyllables would align with a shift from a conservative Kerry/Cork system of phrasal F0 behaviour independent of lexical-level intensity prominence, as hypothesised in the discussion of Model 5. The second 2020-21 maximum F0 model below addresses trisyllables, and is the final model dealing with F0 height in this chapter.

Model 8: F0 height in modern (2020-21) trisyllables

This final model of F0 height (in 2020-21 trisyllables) parallels Model 6 (F0 height in 1928 trisyllables). Convergence was achieved without error, and the requisite posterior predictive check indicated satisfactory performance, as shown in Figure 55.

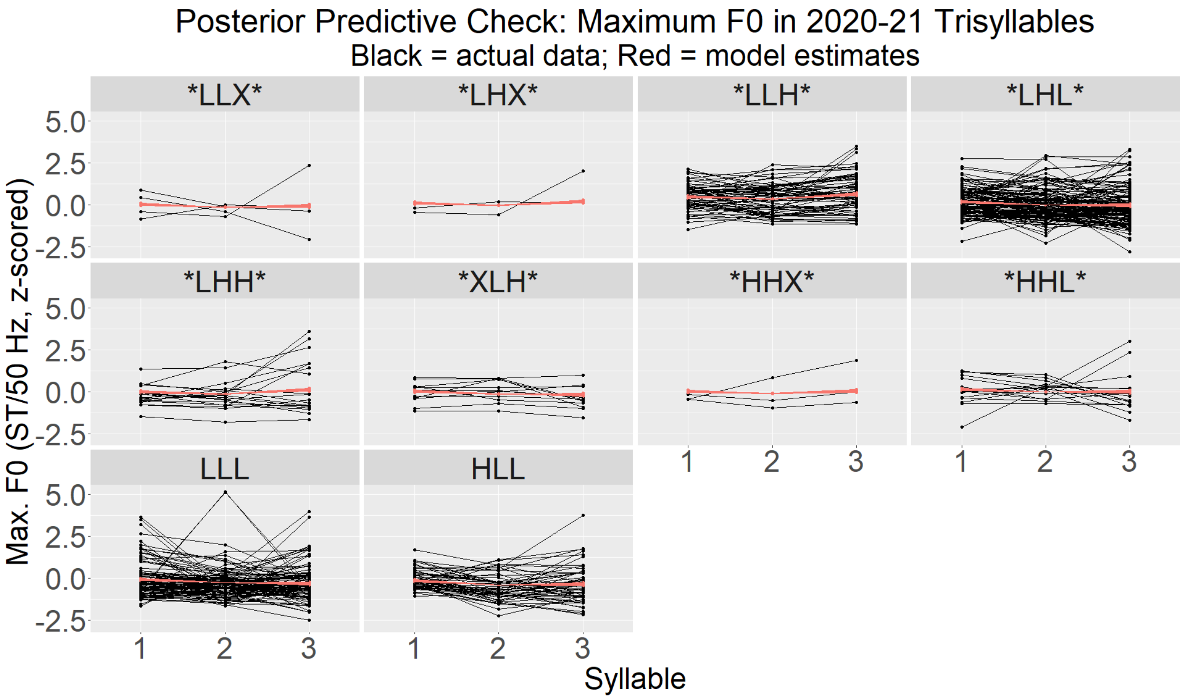

Figure 55 *Prior predictive check for Model 8 (maximum F0 in 2020-21 trisyllables).*

The 95% credible intervals for model by weight structure, presented in Figure 56, look very different to those of the maximum intensity model for the same speakers (Section 5.2.1, Model 4). The latter generally favours initial intensity prominence – regardless of weight-structure – while the present model has the highest upper boundaries for credible F0 maxima occurring in final position. However, these same final syllables also tend to have the widest credible intervals, technically (and non-negligibly) allowing for final-syllable decreases in maximum F0 height and a lack of change from and through initial and medial positions. Like the result of Model 7, the three region groups show no appreciable differentiation from one another (RQ2a), in contrast to such differentiation in the 1928 data (RQ2b).

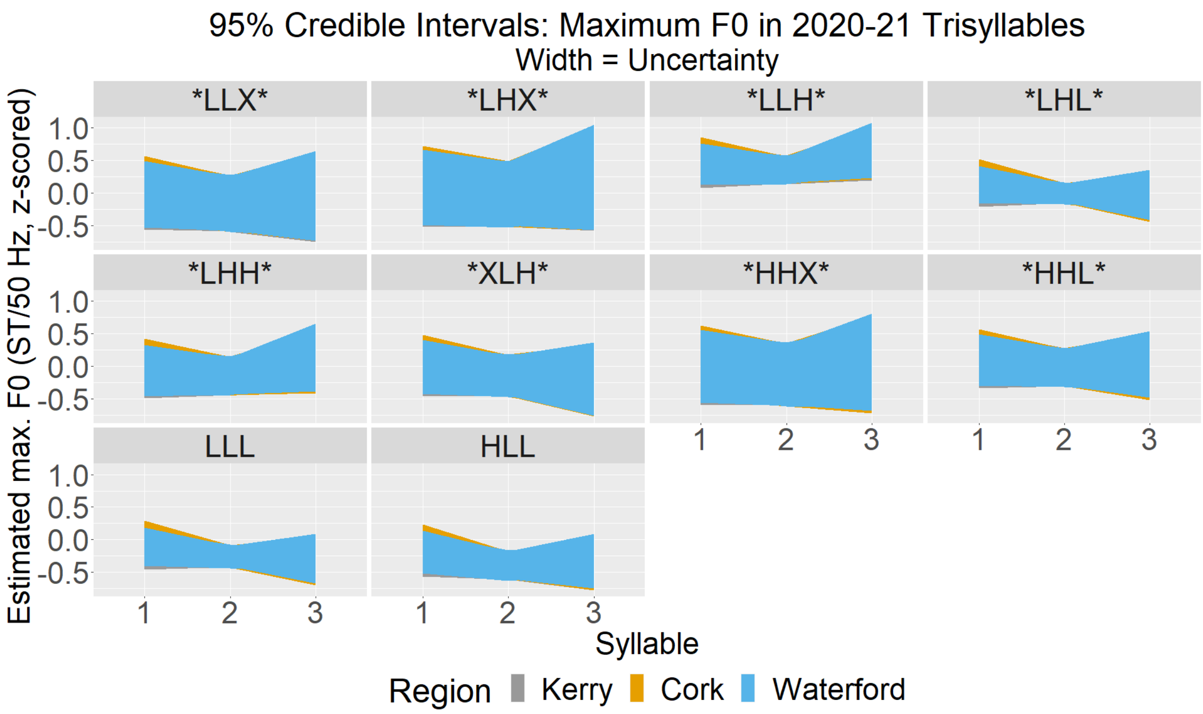

Figure 56 *95% credible intervals by weight structure for Model 8 (maximum F0 in 2020-21 trisyllables).*

The most noteworthy – and potentially informative – patterns evident in Figure 56 are those for shift-eligible LHH and LLH trisyllables, both of which show slightly higher credible interval on final syllables then the preceding two, albeit with substantial overlap. An equivalent 'shift' in heightened F0 maximum is not seen for equally shift-eligible LHL, which has intervals decreasing in height across syllables. It is perhaps noteworthy to recall from Table 9b in Section 5.1 that LHH and LLH in the 2020-21 data are both dominated by plural imperative verbs (e.g. *beirigí* 'bear' or *maraígí* 'kill'), while LHL is lead by nouns such as *ceiliúradh* 'celebration'.

It is conceivable that any final-syllable increase in F0 in LHH and LLH is tied to an imperative intonation pattern of some sort, rather than reflecting PLP location. Certainly, this final F0 increase does not align with predictions for intensity maxima in these same items, both of which have their highest estimates for initial syllables. This is particularly relevant for RQ2, as it shows a potential split between intensity prominence in initial position and increased F0 on a non-initial heavy syllable.

Similar to for the 1928 modelling of the same parameter, for the remaining categories there is little differentiation in maximum F0 behaviour across the various categories; evident variability is more obviously linked to range of uncertainty driven by uneven distribution of weight-structure categories in the data.

Summary of maximum F0 models

To summarise this section, Models 5-8 of maximum F0 height across syllable positions in di- and trisyllables show markedly different results to Models 1-4 of intensity maxima. In the 1928 models (5-6), there is a general preference for a uniform pitch pattern applied to items, apparently regardless of weight structure. However, for the contemporarily weaker varieties of Waterford, Tipperary, and Clare, extrapolated patterns broadly align with those for intensity-prominence in the same regions. Thus, a moderate degree of F0 sensitivity to weight structure for these speakers, while not strongly evidenced, should not be ruled out.

Moving then to 2020-21, there is more differentiation in credible intervals for F0 height by position in all three region groups across the various di- and trisyllabic weight structures. Overall, there is much more uncertainty in model predictions for the present-day data; it would therefore be imprudent to make overly specific claims regarding the relationship between these pitch-height models and PLP location, particularly for trisyllables and less-attested disyllable weight-structures. There is evidence nevertheless that (i) change in F0 height was historically independent of intensity prominence, at the very least in Cork and Kerry (RQ2), (ii) regional variation in treatment of F0 maxima was robust in 1928, in contrast to a uniform 'Munster' system (RQ2a), and (iii) present-day data return markedly different results to the 1928 data, encouraging caution in treating modern data as directly compatible with historical descriptions (RQ2b).

This systematic analysis continues below with Models 9-12 of syllable F0 range in the by now familiar di- and trisyllables from 1928 and 2020-21.

5.2.3 F0 range across syllable positions

I turn now to the other pitch-based potential marker of syllable prominence considered: F0 range within a given syllable. For both era-groups, individual standard deviations for F0 range span approximately 1-5 semitones. This should be borne in mind as a reference for interpreting *z*-units.

As a general note before proceeding, F0 range is somewhat difficult to interpret in isolation from F0 height (explored in the previous section). The same is not true, at least not to the same extent, for the reverse, although local range information can undoubtedly aid the interpretation of high (or low) F0. Additionally, perceptual salience derives from aurally integrated pitch, voice quality, and durational cues: syllables with a considerable range of pitch produced in a short timeframe may be perceived as more 'prominent' in a sense than neighbouring syllables with more extreme F0 values in a more constrained range (Rietveld & Gussenhoven 1985). Just as high F0 does not necessarily indicate phonological prominence, so a wide F0 range does not in itself make for a prominent syllable. A wide F0 range on a given syllable may reflect, e.g., a transition to or away from pitch-prominence on an adjacent syllable.

Ideally, F0 height and range would be considered together, something which would be more straightforward if a syllable's PLP status, for example, were the dependent variable and F0 height, range, and their interaction were considered as predictors. Under the current arrangement, however, PLP location is specifically *not* being assumed, and such joint/interactive consideration is not so simple. For the exploratory purposes of this study, it has sufficed to consider each of the four selected prominence exponents in modular isolation; future work may – and is encouraged to – approach these data from a different analytical perspective.

In broad terms, there appears to be a positive correlation between a given syllable's F0 maximum and range, as illustrated in Figure 57. There are evidently exceptions to this trend, and the positive relationship is defined in large part by more extreme values while the majority of datapoints cluster around speaker-average with a less sharp relationship between height and range. Nevertheless, it is useful to consider that – for more extreme values in particular – an increased range within a syllable is associated with a relatively high F0 value for a speaker's observed spread.

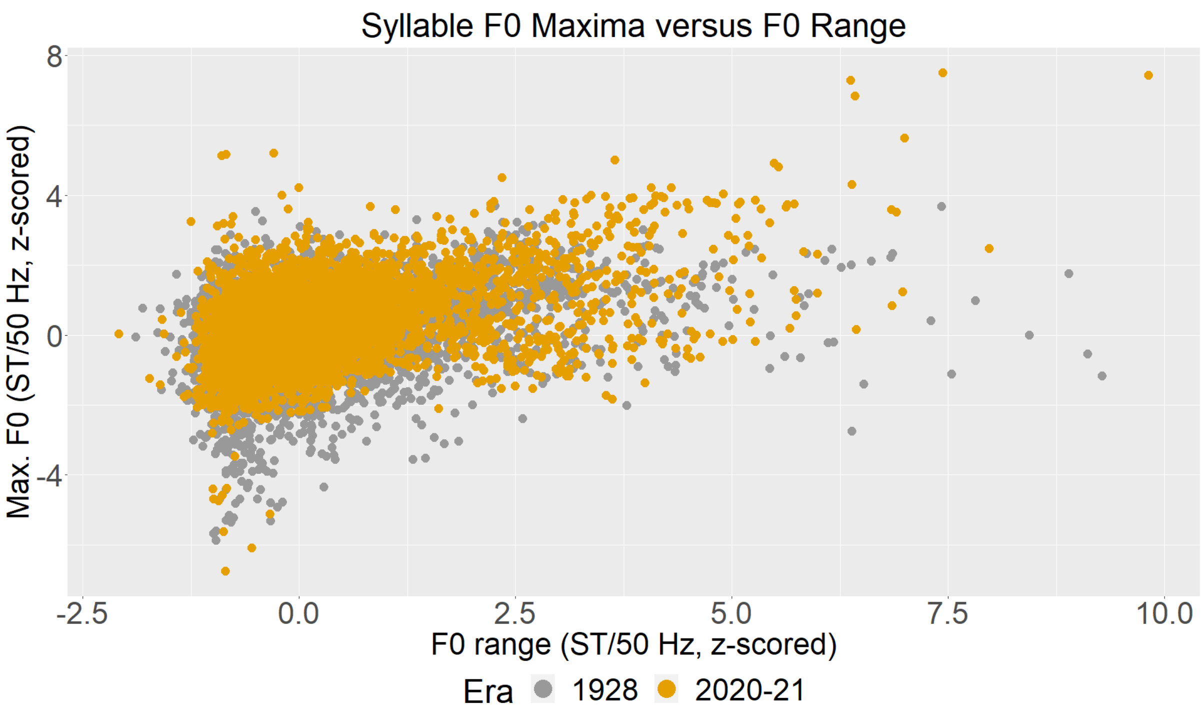

Figure 57 *Scatterplot of maximum F0 versus F0 range in syllables. There is a weak positive correlation between the two measures in both eras, but substantial variation is evident.*

The order of model presentation in the remainder of this section should by now be familiar, if somewhat formulaic: analysis of 1928 di- and trisyllables (Models 9-10), followed by 2020-21 di- and trisyllables (Models 11-12).

Model 9: F0 range in 1928 disyllables

The first F0 range model to be considered (Model 9) deals with disyllables in the 1928 data, in parallel to Models 1 and 5 of intensity and F0 height. This model converged without error, and a posterior predictive check (Figure 58) indicates satisfactory performance. 95% credible intervals by weight structure are presented in Figure 59. Unlike for F0 height in Model 5, this model of F0 range makes uniform predictions across regions for 1928 disyllable data, with variation evident across the nine weight-structure categories. This presents a rather stark contrast with Model 5's bifurcation of region groups into a Kerry/Cork pattern invariant across weight structures (and presumed to be conservative) and a Waterford/Tipperary/Clare pattern with apparently weight-related and intensity-parallel variation in F0 height across syllables. Regarding RQ2a, this is then a case of pan-Munster uniformity in the 1928 data.

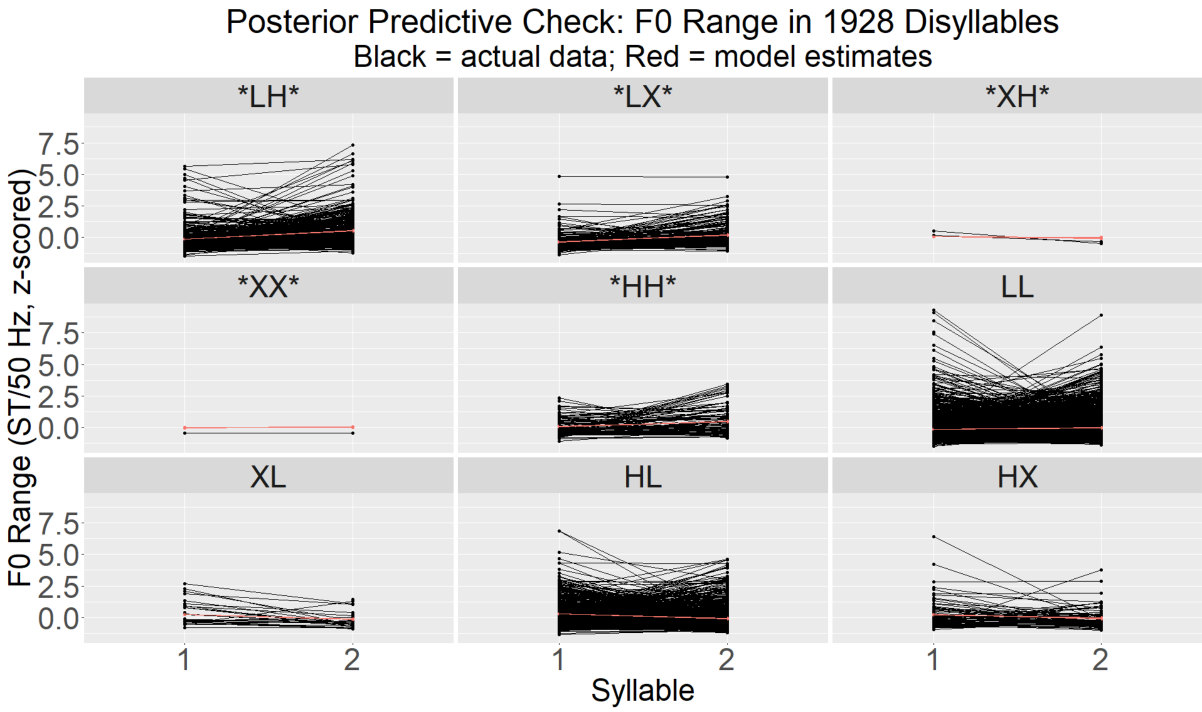

Figure 58 *Prior predictive check for Model 9 (F0 range in 1928 disyllables).*

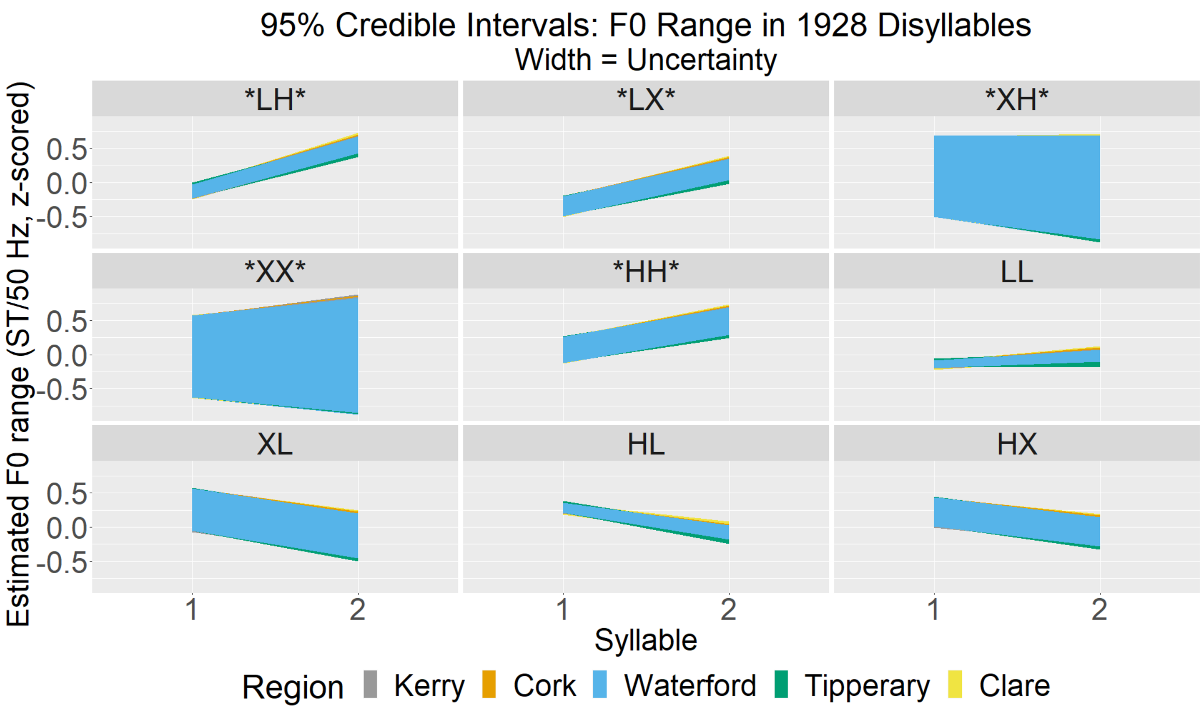

Figure 59 *95% credible intervals by weight structure for Model 9 (F0 range in 1928 disyllables).*

For initial-PLP structures, narrower final ranges are predicted for HX and XL, with no appreciable change for LL. Wider F0 ranges are predicted for final syllables in items with shift-eligible structures HH, LH, and LX, while shift-eligible XH and marginal XX have insufficient data to generate meaningful predictions. Model estimates and CIs for the latter two are of virtually no interpretative value beyond describing the highly limited data themselves. By contrast, CIs for HL, LH, LL, and LX are remarkably narrow in contrast to those for F0 height estimates in Model 5.

Wider F0 ranges are seen to be estimated for the same three shift-eligible categories (HH, LH, and LX) that were estimated to have higher or unchanged F0 maxima in final syllables in Model 5 (Figure 48). With respect to RQ2, this could be taken to suggest that both F0 features under consideration align with expected right-shifted PLP in the 1928 disyllable data. However, recall that a cross-syllable F0 increase was the invariant norm for Cork and Kerry speakers, and that remodelling of restricted LX data in Model 5b showed no change in predictions for any speakers. This was taken to support possibly PLP-insensitive F0 patterns for conservative Cork and Kerry speakers in 1928, and to be ambiguous in regards to any consistent F0 patterns in Waterford, Tipperary, and Clare. Further, in cases of conflicting directionality of F0 maximum change in Model 5 (HL, HX, XL), Figure 58 for Model 9 shows moderate declines in F0 range.

In other words, it is true that F0 range may align with higher or unchanged final F0 maxima possibly indicative of right-shifted PLP in Waterford, Clare, and Tipperary. However, for Cork and

Kerry, Model 9's estimates of greater final-syllable F0 range in shift-eligible structures are more likely the by-product of invariant cross-syllable F0 rises incidentally aligning with genuinely weight-variant trends in the other three regions. Thus, this model evidences regional uniformity to an extent (RQ2a), but does not strongly support unambiguous, multiply-signalled, right-shifted PLP for all five regions in 1928 disyllables (RQ2). Exploration of F0 range in the 1928 data continues below with trisyllables.

Model 10: F0 range in 1928 trisyllables

Continuing to trisyllables in the same 1928 data, the model of F0 range as a function of syllable position converged without error, evident in a posterior predictive check (Figure 60). 95% credible intervals for F0 range in the joint posterior distribution, shown in Figure 61, are uniform across region-groups and (generally speaking) across weight-structure categories. However, they are uniform only in estimating that medial syllables are likely to have a more restricted pitch range more narrowly approximating speaker-average. This is consistent with the structural invariance shown for the behaviour of F0 height across these same items in Model 6, at least insofar as the model has sufficient data to extract meaningful patterns.

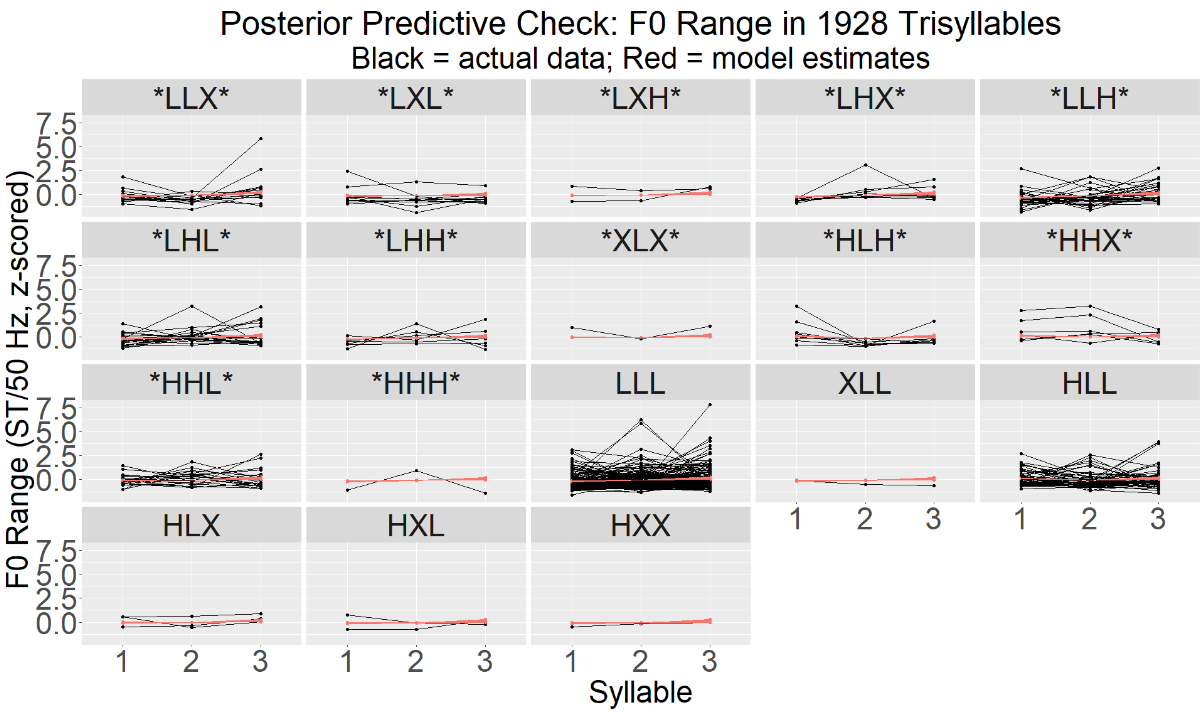

Figure 60 *Prior predictive check for Model 10 (F0 range in 1928 trisyllables).*

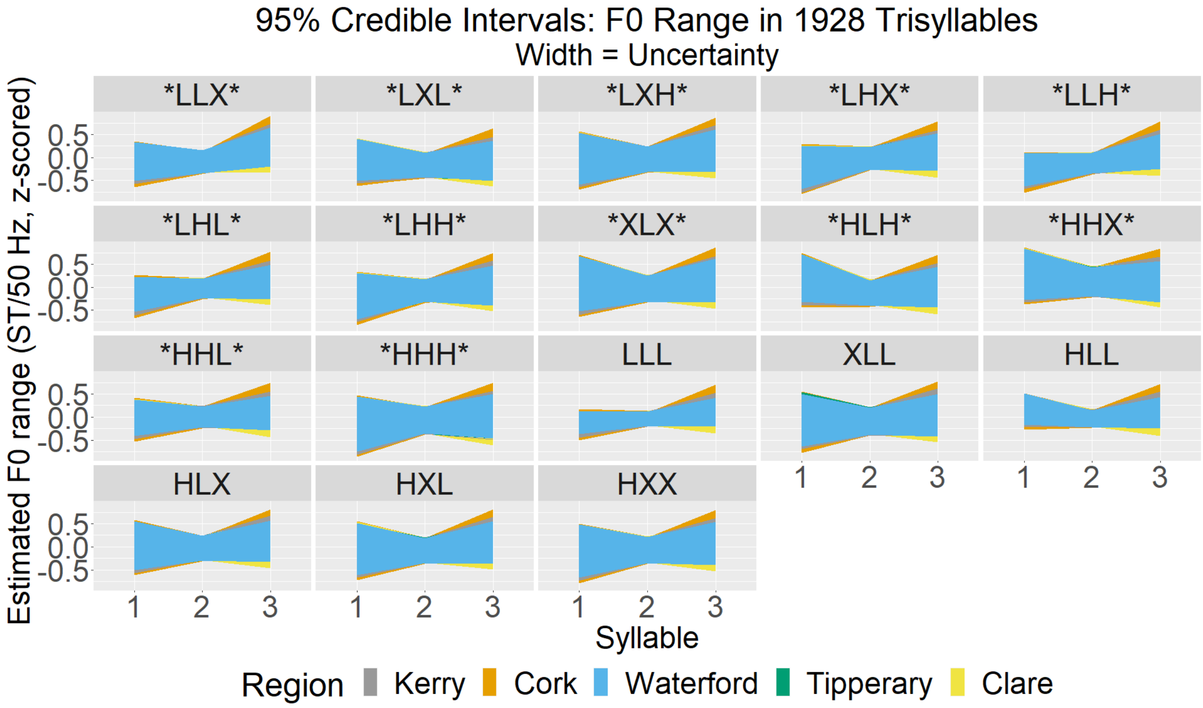

Figure 61 *95% credible intervals by weight structure for Model 10 of F0 range in 1928 trisyllables.*

It is evident that these estimates are not greatly informative, and that narrower CIs for, e.g., LLL present the same basic pattern, only with greater credibility due to a larger amount of data. Wider F0 ranges are estimated for final syllables in some structures (e.g. LLX, LLH, LHL, LLL), but this does not exclusively align with expected shifted PLP location (e.g. in LHL or LLL). Thus, this model does not bring much to bear on the answering of RQ2 regarding correspondence of various potential markers of PLP location. Regional estimates vary slightly from one another, particularly in final position. This variability is similar to that seen above for the F0 maxima models (5-6) for the same era group, weakly contributing to the body of evidence against pan-Munster uniformity interrogated by RQ2a.

Having now explored F0 range in the 1928 data, I turn to equivalent modelling of the present-day (2020-21) data in order to address RQ2b in additions to RQs 2/a.

Model 11: F0 range in modern (2020-21) disyllables

Turning then to the modern data, beginning with disyllables, Model 11 converged without error and performed satisfactorily in a posterior predictive check as shown in Figure 62.

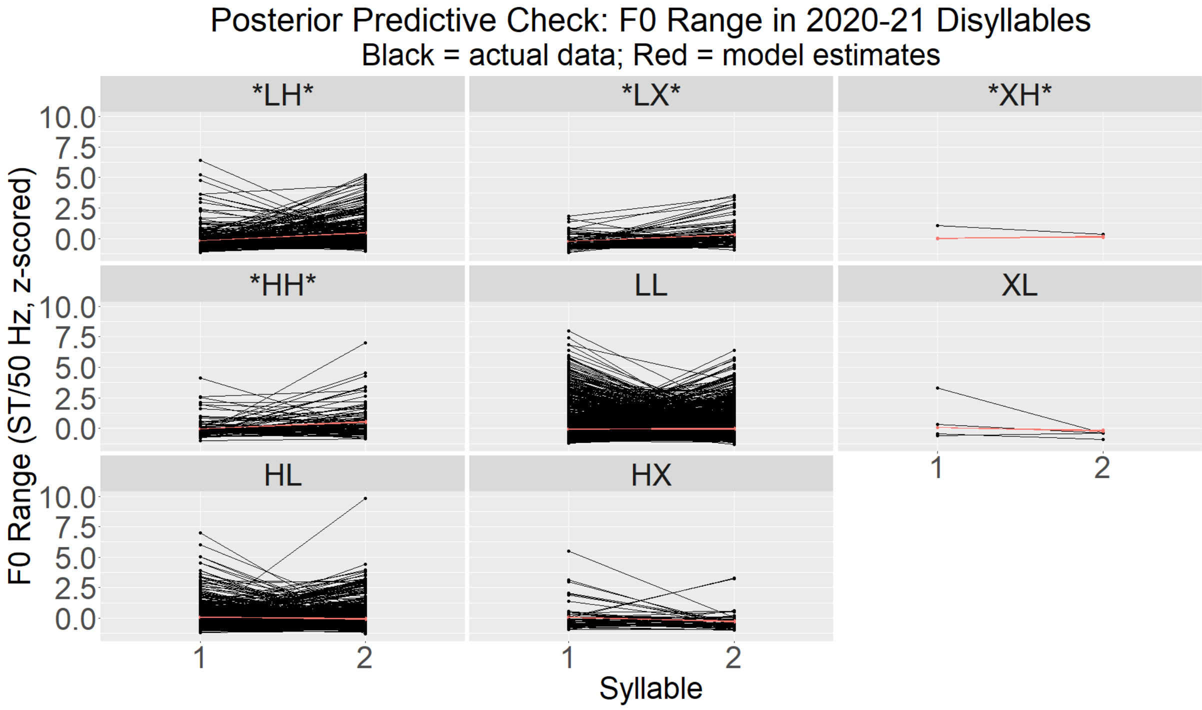

Figure 62 *Prior predictive check for Model 11 (F0 range in 2020-21 disyllables).*

The picture for present-day disyllables' credible intervals in Figure 63 is virtually identical to that for Model 9 of F0 range in the 1928 disyllable data, as well as to Model 7 of F0 maxima for these same 2020-21 disyllables. Predictions of a positional effect on F0 range are most robustly credible for shift-eligible categories HH, LH, and LX, for which final syllables are tightly estimated to have wider F0 ranges in final position. Final syllable estimates are seen in these cases to change from average or slightly below-average range in in initial syllables to slightly above-average.

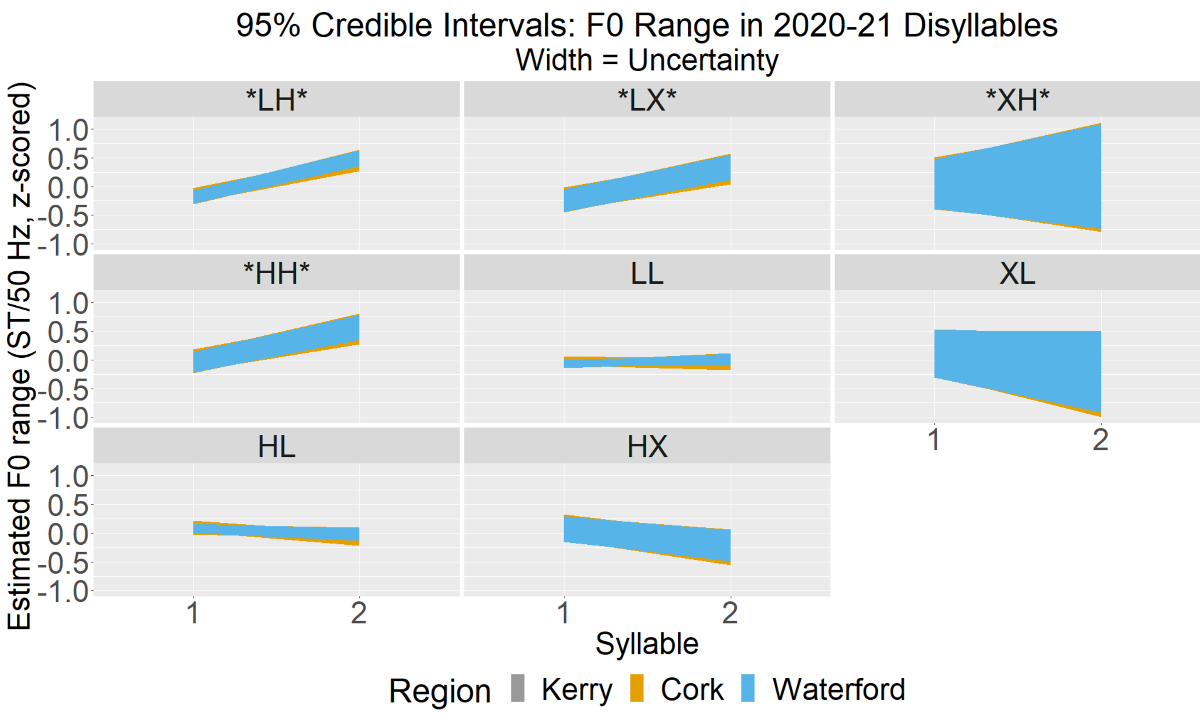

Figure 63 *95% credible intervals by weight structure from Model 11 (F0 range in 2020-21 trisyllables).*

For structures with expected initial PLP, a cross-syllable narrowing of range is predicted for HX items, while the model is unable to provide meaningful estimates of change in range for XH and XL due to insufficient data. HL and LL meanwhile show very narrowly constrained credible intervals which indicate a possible slight decrease in range for HL (with uncontroversial initial PLP) and no change between positions for LL (dominated by high-frequency function word *agus* 'and'). This corresponds to estimated flat F0 for these two structures in Model 7 of F0 height. Regarding RQ2, this shows increased F0 range in modern disyllables aligning with expected right-shifted PLP location. This is consistent across the three subregions in question (RQ2a), and corresponds to F0 range estimates for disyllables in the 1928 data (RQ2b). As for 1928 disyllables in Model 9, remodelling of restricted LX data was eschewed on the basis of unchanged results for remodelling of F0 height.

Model 12: F0 range in modern (2020-21) trisyllables

The final model of F0 range by syllable position examines trisyllables in the modern data. As with Models 1-11, the model converged with no issue, and this is reflected in the posterior predictive check shown in Figure 64. 95% credible intervals for F0 range present-day trisyllables, shown in Figure 65, are not greatly distinct from those for the 1928 Doegen data (Model 10). Model results are broadly consistent across regions (RQ2a), with credibility dependent on the quantity of data supplied per category. There is an apparent tendency for a higher boundary of the F0 range 95% CI final syllables for Waterford (i.e. a credibly wider maximum F0 range), and a lower boundary in the same position for Cork (i.e. a credibly narrower minimum F0 range), with estimates for Kerry (obscured in Figure 65) falling in between.

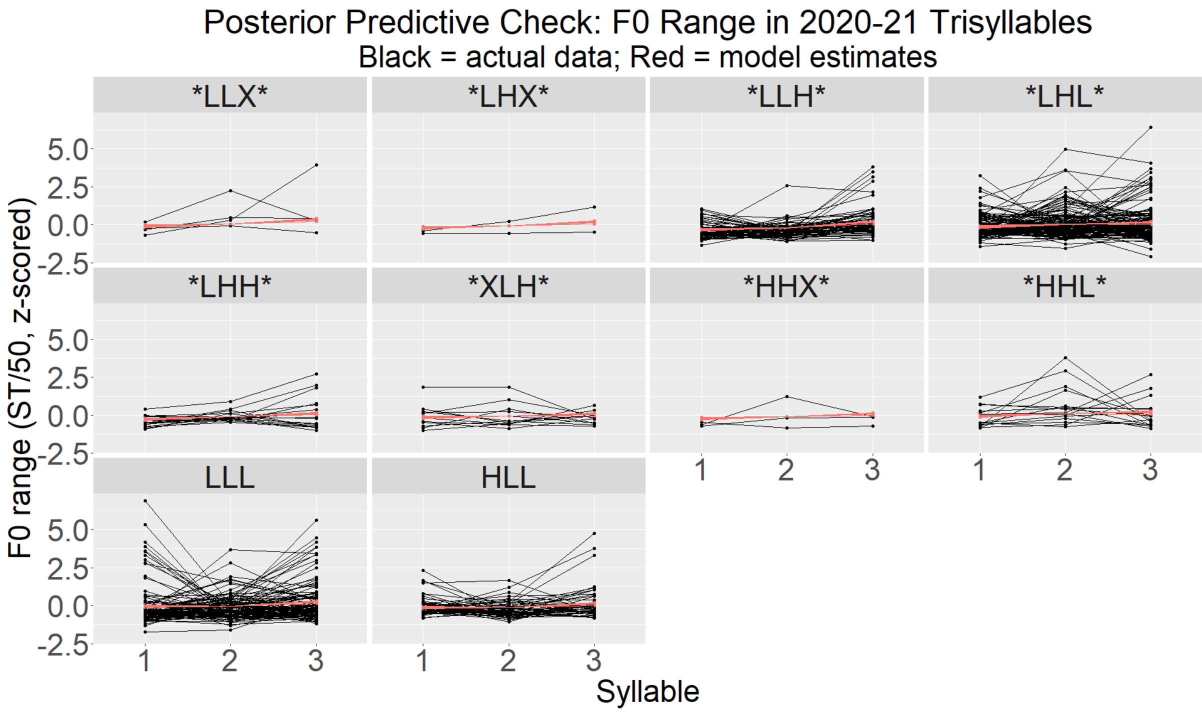

Figure 64 *Prior predictive check for Model 12 (F0 range in 2020-21 trisyllables).*

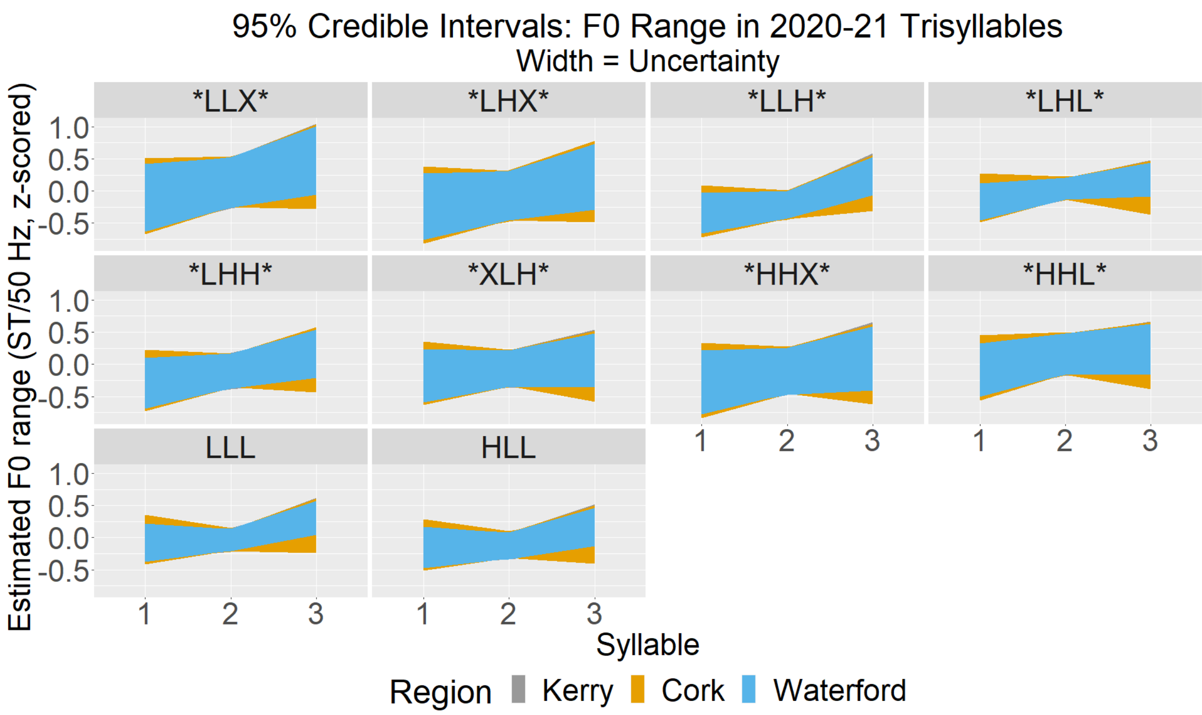

Figure 65 *95% credible intervals by weight structure for Model 12 (F0 range in 2020-21 trisyllables).*

Unlike for disyllables from this era (Model 10), model results for trisyllables do not entirely correspond to those for its F0 height counterpart (Model 8), but differences are minimal. The most credible positional effect evident – with little to no overlap between credible intervals for a single prominent syllable and the other two – emerges for the shift-eligible LLH category, in which all speakers are estimated to have a wider F0 range in the final heavy syllable (0.5z above average, in contrast to 0.5z *below* average for the preceding two light syllables). This aligns with marginal estimations of higher F0 maxima in these same syllables, providing weak support for pitch parameters corresponding to expected PLP in a non-initial heavy syllable for 2020-21 speakers (RQ2/b).

Summary of F0 range models

In summary, Models 9-12 were built to examine F0 range over the course of di- and trisyllables in the 1928 and 2020-21 datasets. The results differed somewhat from those seen for Models 5-8 of maximum syllable F0 in these data, with relatively uniform predictions between the two eras, including wider final-syllable F0 ranges for shift-eligible LH, LX, and HH. For modern disyllables (Model 11), F0 range seems to parallel F0 height for the same items (Model 7), with syllables estimated to have increased F0 maxima also estimated to exhibit wider F0 ranges. Both sets of trisyllable results (Models 10 and 12) are characterised by wide credible intervals in initial and final position for most weight-structures, and substantial overlap between intervals across all three positions; the latter makes a real pattern (weight-driven or otherwise) underlying the data difficult to meaningfully infer.

In reference to RQ2, the results of these models indicate that (i) F0 range sometimes aligns with right-shifted PLP descriptions, but does not always or necessarily correspond to estimates for F0 height and intensity in Models 1-8 (RQ2), (ii) modern speakers' treatment of F0 range is largely consistent across region, and this is the case for 1928 disyllables but not entirely for 1928 trisyllables (RQ2a), and (iii) change is evident between 1928 and 2020-21 (RQ2b).

5.2.4 Vowel duration across syllable positions

This final set of models deals with another suprasegmental feature often associated cross-linguistically with PLP, namely vowel duration. As outlined in the sketch of the language's segmental phonology in Chapter 3, Irish exhibits contrastive vowel length in addition to a basic five-quality distinction. Given the evidence for languages to disprefer the use for PLP-marking of features which independently play a role in segmental phonology (cf. discussion of the Functional

Load Hypothesis in Section 2.1.2), there are grounds for scepticism with regards to effect of PLP on Irish vowel duration.

However, Irish is typically described as exhibiting reduction of vowel duration in non-PLP syllables (‘unstressed vowel reduction’), and it therefore seemed worthwhile to include a measure of this in the interest of thoroughness. Recall from Section 5.1 that in order to compensate for the phonological quantity contrast, log-transformed vowel durations were not z-scored by speaker, but rather by length-category within speaker. As such, the pooled data supplied to Models 13-16 represent relative vowel durations within the long and short vowel systems. This allows for joint modelling of both long and short vowels.

Short vowels in both eras had an average duration of approximately 60 ms versus approximately 160 ms for long vowels. Once log-normalised, speakers in both eras had standard deviations ranging from roughly 0.2-0.5 log. ms for both length categories. Thus an increase in 1z represents an increase of 0.5 log. ms for a speaker with a length-category standard deviation of 0.5.

Model 13: Vowel duration in 1928 disyllables

This model converged without error. The posterior predictive check illustrated in Figure 66 on the following page indicates satisfactory performance of the model in generating predicted values for the data in line with actual observed values. 95% credible intervals for model estimates are then presented in Figure 67.

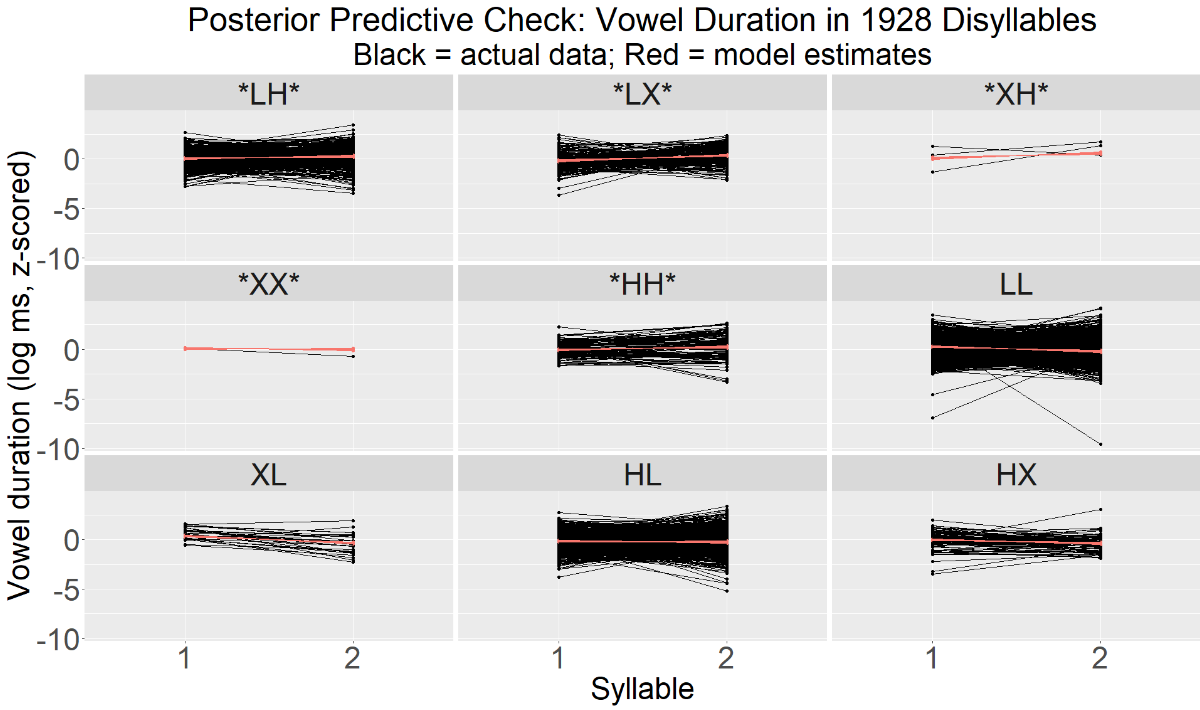

Figure 66 *Prior predictive check for Model 13 (vowel duration in 1928 disyllables).*

Immediately noteworthy in Figure 67 below is the consistency in model estimates and credible intervals across the five 1928 subregions, in contrast to regional variation for intensity (Model 1) and F0 height (Model 5). Turning first to weight structures with uncontroversial initial PLP in Figure 67, final vowels are predicted to be shorter relative to a speaker's average duration for the relevant length category in HX, LL, and XL items. For HL items, vowels for both syllables are predicted to have durations slightly below average. This may be related to the overwhelming predominance of *tháinig* 'came' in the HL category (see Table 8 in Section 5.1), as this item virtually never occurred under any form of focus and may consequently have been slightly reduced.

For shift-eligible categories LH, LX, XH, XX, and HH, there is little clear evidence of reduction in (relative) vowel duration for initial syllables. As established in Sections 5.2.1-5.2.3, available evidence for XH and XX categories is extremely scarce, limiting the credibility of model estimates. For LH and HH, it is worth noting that although the long vowels in final heavy syllables may be slightly longer than average (up to +0.5z), the short vowels in initial syllables are not *below* average. This is difficult to reconcile with initial syllable reduction tied to culminative phonological prominence in final position, at least insofar as vowel duration independent of phonological length relates to PLP-marking in Irish.

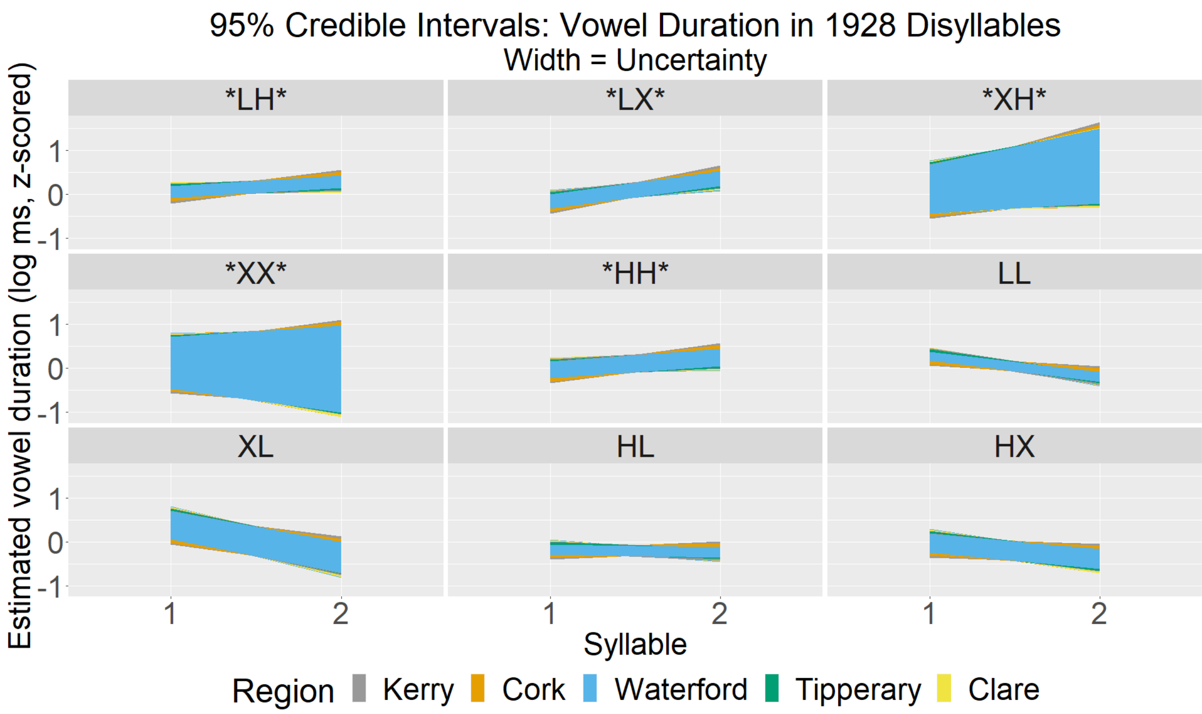

Figure 67 *95% credible intervals by weight structure for Model 13 (vowel duration in 1928 disyllables).*

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Finally, by comparison, initial syllable in LX items are predicted to have vowels slightly below speaker short-vowel average, seemingly more consistent with final PLP and related non-PLP vowel reduction in an initial light syllable. However, if – as for previous disyllable models of intensity and pitch height – high-frequency LX *isteach* and *amach* are excluded (Model 13b), this effect disappears. In Figure 68 on the following page, it can be seen that Model 13's estimated 0.5z increase from roughly -0.25 SDs below category-average duration to 0.25 SDs above in LX items is replaced in Model 13b by an estimated positional change of equal magnitude in the opposite direction.

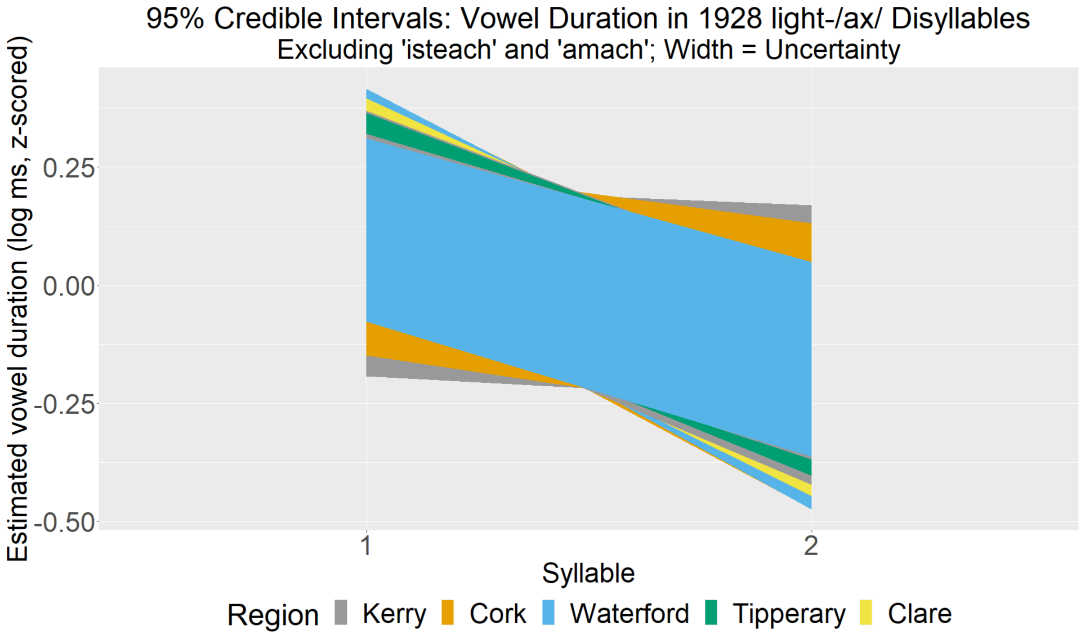

Figure 68 *95% credible intervals for light-/ax/ disyllables from Model 13b (vowel duration in 1928 disyllables, excluding high-frequency* isteach *and* amach *from the data). The model now estimates a slight decrease in final-syllable vowel duration, in contrast to the slight increase estimated in the original Model 13 (Figure 66).*

Model 13 thus shows little support for vowel duration as indicating right-shifted PLP, although final-syllable long vowels in LH and HH are estimated to be slightly above average in duration (RQ2). Estimates and credible intervals for the five subregions also pattern together, in contrast to heterogeneity in intensity and F0 height models for these same disyllables (RQ2a). This may be more easily reconciled with roughly category-average vowel durations regardless of item weight-structure, with possible contextual-prosodic effects on final syllables. The final 1928 model below considers vowel duration in trisyllables.

Model 14: Vowel duration in 1928 trisyllables

Model 14 follows the same general structure as previous models of intensity and pitch parameters for trisyllables, and converged without error. The posterior predictive check provided in Figure 69 indicates satisfactory performance. 95% credible intervals in Figure 70 show clear differentiation in predictions for relative vowel duration across trisyllabic weight-structure categories. As for Model 13, duration estimates appear consistent across all regions (RQ2a).

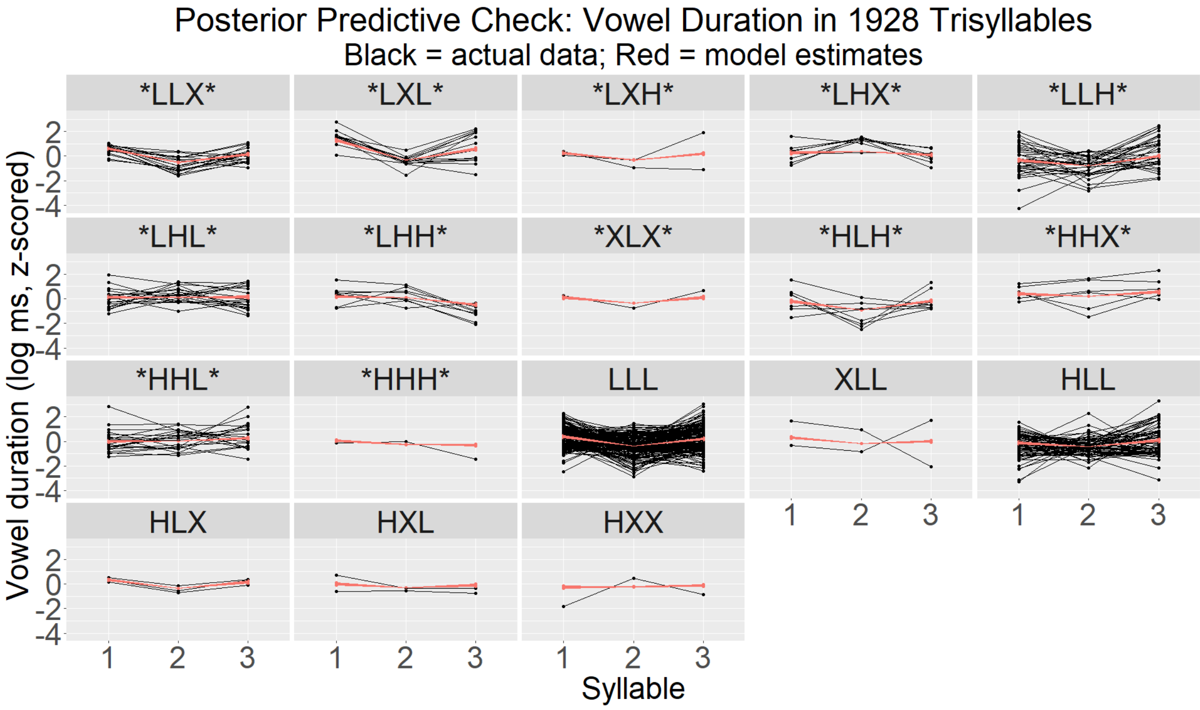

Figure 69 *Prior predictive check for Model 14 (vowel duration in 1928 trisyllables).*

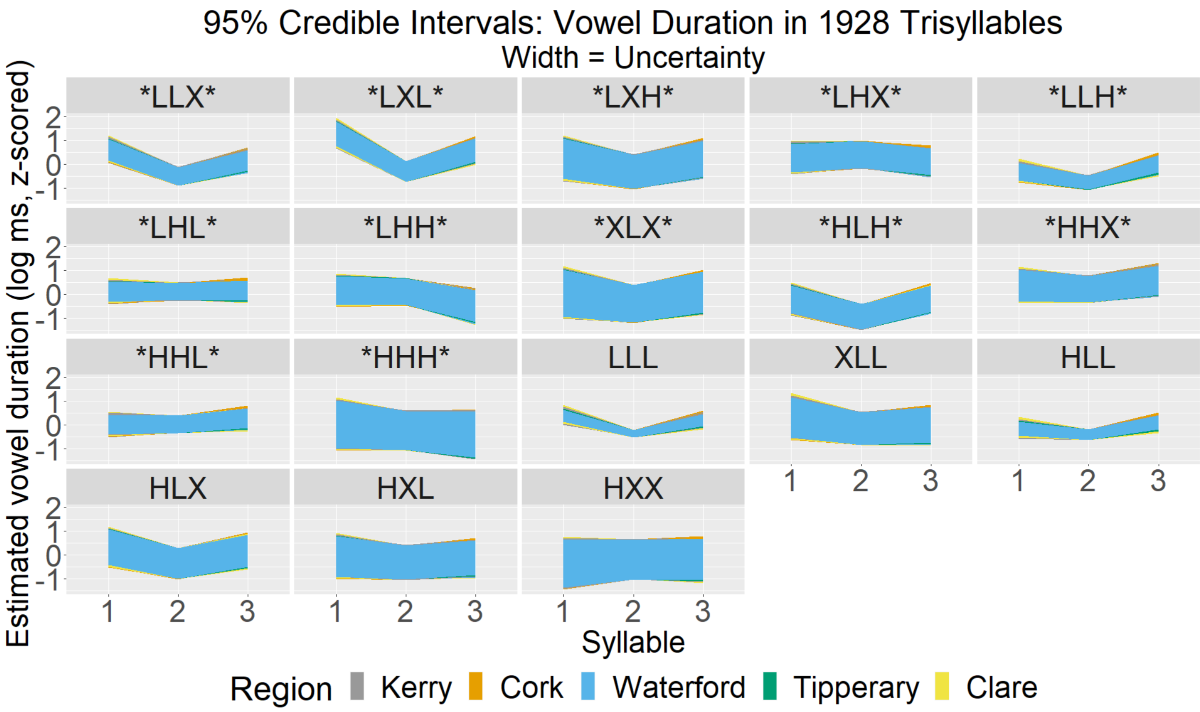

Figure 70 *95% credible intervals by weight structure from Model 14 (vowel duration in 1928 trisyllables).*

Turning first to items with uncontroversial initial PLP (HLL, HLX, HXL, HXX, and XLL), estimates in Figure 70 generally agree on slightly below-average durations for vowels in medial syllables. Beyond this, there is a split between marginal predictions of above-average vowel duration in initial heavy and /ax/ syllables for HLX, HXL, and XLL – the uncontroversial location of PLP in such structures – and roughly average vowel durations in both initial and final position for HLL and HXX.

For the remaining 13 structures with expected non-initial PLP under some accounts of shifted 'Munster' PLP, there is no evidence for durational prominence in medial or final position. HHL and HHX items are predicted to have roughly average vowel durations across all three syllables. LXL items, meanwhile, have notably above-average vowel durations predicted for initial position, followed by lower but still above-average durations in final position, and slightly *below*-average durations in the medial position predicted to bear PLP under received accounts. This would appear to be another blow for the productive, exceptional medium-heavy weight status of /ax/ syllables above their other short-vowel counterparts, particularly given the relatively high credibility of the LXL comparisons versus those for many of the other 17 weight-structure categories.

For HHH and LHH, vowels are predicted to be at their category-relative longest in initial position. For LLH, LLX, LXH, and XLX, initial and final syllables are predicted to have roughly equivalent category-relative durations with a medial-syllable dip. Within those two groups, two caveats should be added: (i) for LHH, final syllables' vowels are not only not predicted to have the longest relative duration, they are in fact predicted to be slightly *below* average after two vowels of relatively average duration in initial and medial position, and (ii) LLH is the only one of the seven categories with predicted final PLP to have at least marginally above-average vowel durations estimated for final position. This category is led in frequency by the items *deartháir* 'brother' and *feirmeoir* 'farmer' (Table 9a, Section 5.1), both trisyllabic only by virtue of an epenthetic schwa in medial position.

What this indicates regarding RQ2 is that for only one out of twelve weight-structures expected to have non-initial PLP (LLH) do results for Model 14 suggest non-initial durational prominence. Further, vowel duration in final syllables above a speaker's length-category average – most clearly seen in LLH but also in less conclusively final-prominent 'V' shapes for, e.g., HLH, HLX, or LXL – could be at least in part caused by phrase-final lengthening. This is not controlled for in the present data, which combine lexical items from various prosodic positions. This is the final model to examine lexical prominence in the 1928 storytelling data. Models 15-16 below comprise corresponding examinations of vowel duration in the 2020-21 data.

Model 15: Vowel duration in modern (2020-21) disyllables

This model of relative vowel duration in disyllables produced by present-day speakers converged without error, and performed satisfactorily in a posterior predictive check as seen in Figure 71.

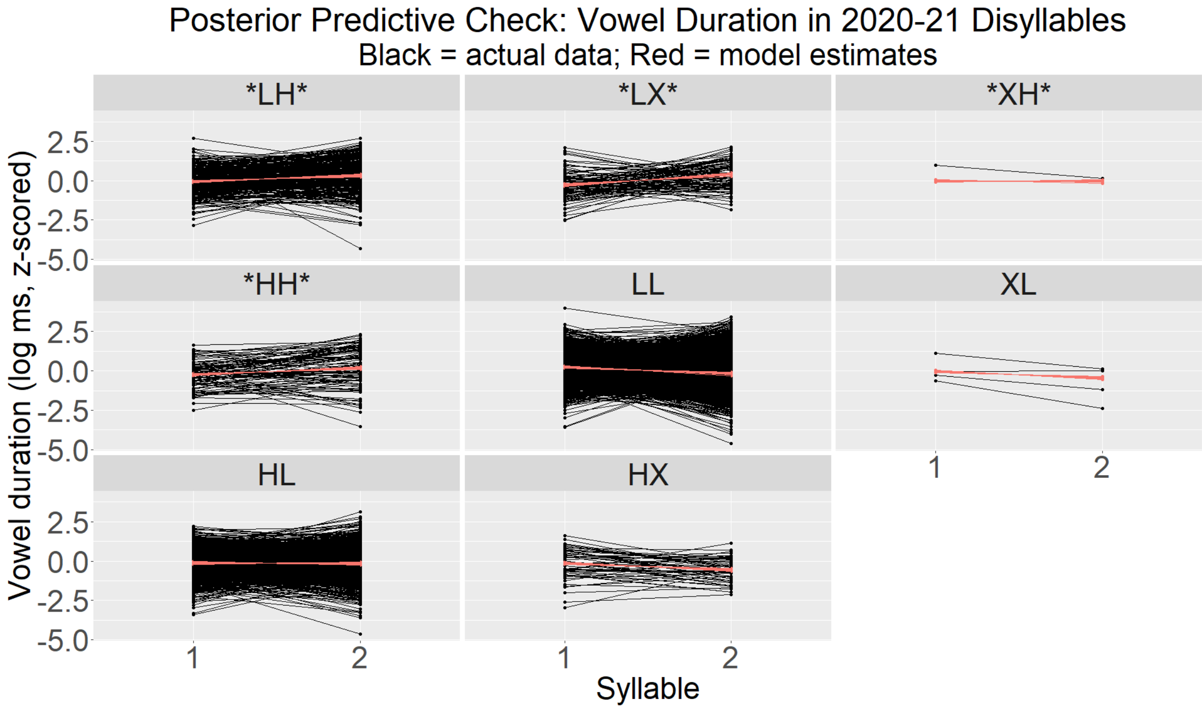

Figure 71 *Prior predictive check for Model 15 (vowel duration in 2020-21 disyllables).*

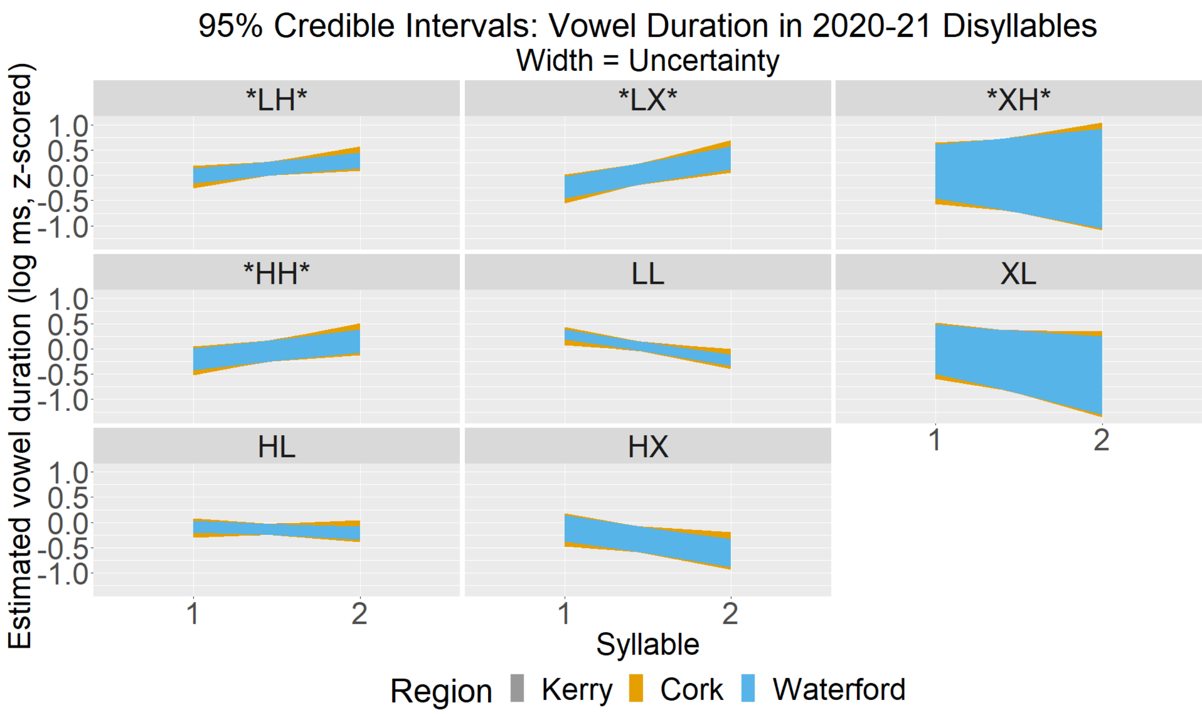

Figure 72 *95% credible intervals by weight structure for Model 15 (vowel duration in 2020-21 disyllables).*

The 95% CIs which emerge in the joint posterior distribution, shown in Figure 72, are extremely similar to those for the equivalent model of 1928 disyllables (Model 13). For uncontroversially initial-PLP HL, HX, and LL, vowel durations are predicted to be relatively shorter and slightly below average in final syllables (HX, LL) or roughly average across both syllables (HL). Model results for XH and XL are limited in utility by the paucity of input data; potentially PLP-shifted XH has no informative predictions, and expected initial-PLP XL shows marginal conformity to this expectation with slightly shorter vowel durations in final light syllables. For shift-eligible HH, LH, and LX, vowels in final syllables are estimated to have durations above their category average. Unlike for the 1928 data, however, the first vowel of HH items is predicted to be slightly below average. This is more consistent with the possibility of non-PLP vowel-reduction than the predictions of roughly average long-vowel/diphthong duration in words of the same structure in 1928. For LH targets, this predicted duration-reduction in initial syllables is not replicated; the short vowels of initial light syllables in such structures are predicted to be of category-average duration.

First-vowel durational reduction is most evident in the predictions for LX as in Model 13, but the role of lexical frequency in this can be interrogated by excluding *isteach* and *amach* from consideration, as in Model 15b. Under the latter model, CIs for LX items of which are shown in Figure 73, the predictions robustly reverse; the vowels of final /ax/ syllables are now predicted to be average or slightly below-average, compared to slightly above-average vowel durations for initial syllables.

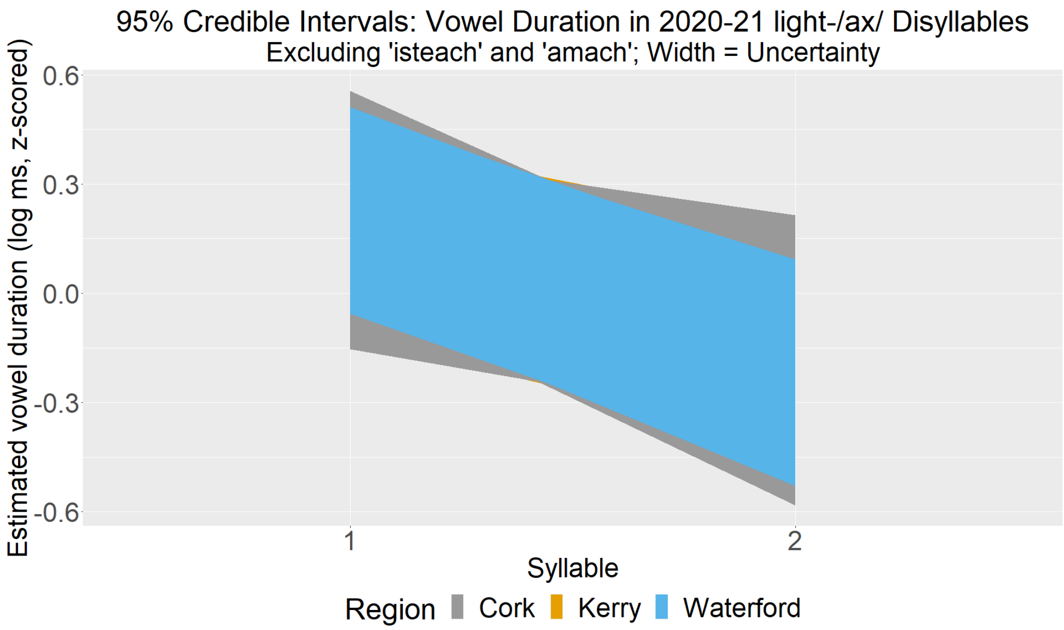

Figure 73 *95% credible intervals for light-/ax/ disyllables from Model 15b (vowel duration in 2020-21 disyllables, excluding high-frequency* isteach *and* amach *from the data). As for Models 13/b, the model now estimates a slight reduction in final-syllable vowel duration, in contrast to the slight increase estimated in the original Model 15 (Figure 71).*

Regarding RQ2, this model shows marginal vowel-durational support for final prominence in two of three weight structures with expected PLP-shift (LH and HH). However, for LX, this effect reverses if high-frequency *isteach* and *amach* are excluded from consideration. Model estimates are generally consistent across regions (RQ2a), and align overall with results for parallel Model 13 of 1928 disyllables (RQ2b).

Model 16: Vowel duration in modern (2020-21) trisyllables

Finally, we come to relative vowel duration across syllable positions in modern (2020-21) trisyllables – the last of the real-word prominence models described in this chapter. The model converged without error and performs satisfactorily in its posterior predictive check, illustrated in Figure 74.

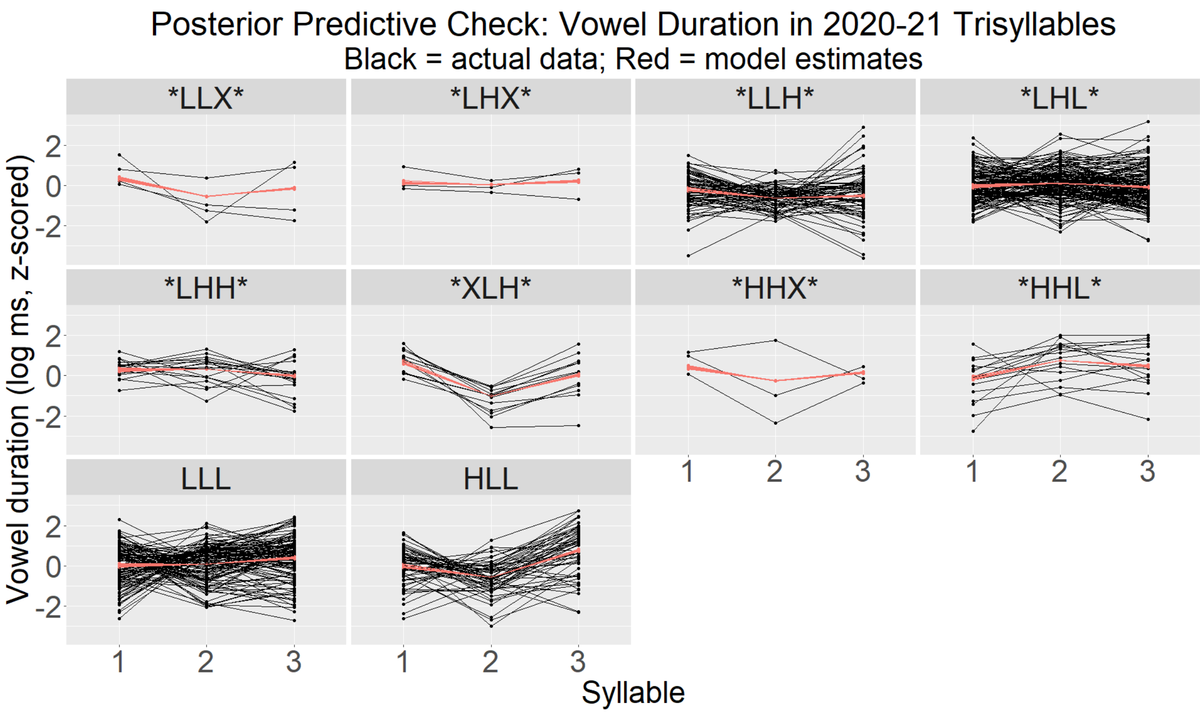

Figure 74 *Posterior predictive check for Model 16 (vowel duration in 2020-21 trisyllables).*

The 95% credible intervals for this model, plotted in Figure 75, show some notable differences in comparison with Model 14 of 1928 trisyllable data. Beginning with weight-structures with expected initial PLP (HLL, LLL), final syllables are – unusually – predicted to have longer vowels than initial or medial ones. This is more robust for HLL, for which plotted credible intervals form a ‘checkmark’, than it is for LLL, which shows something approximating a linear increase across syllables.

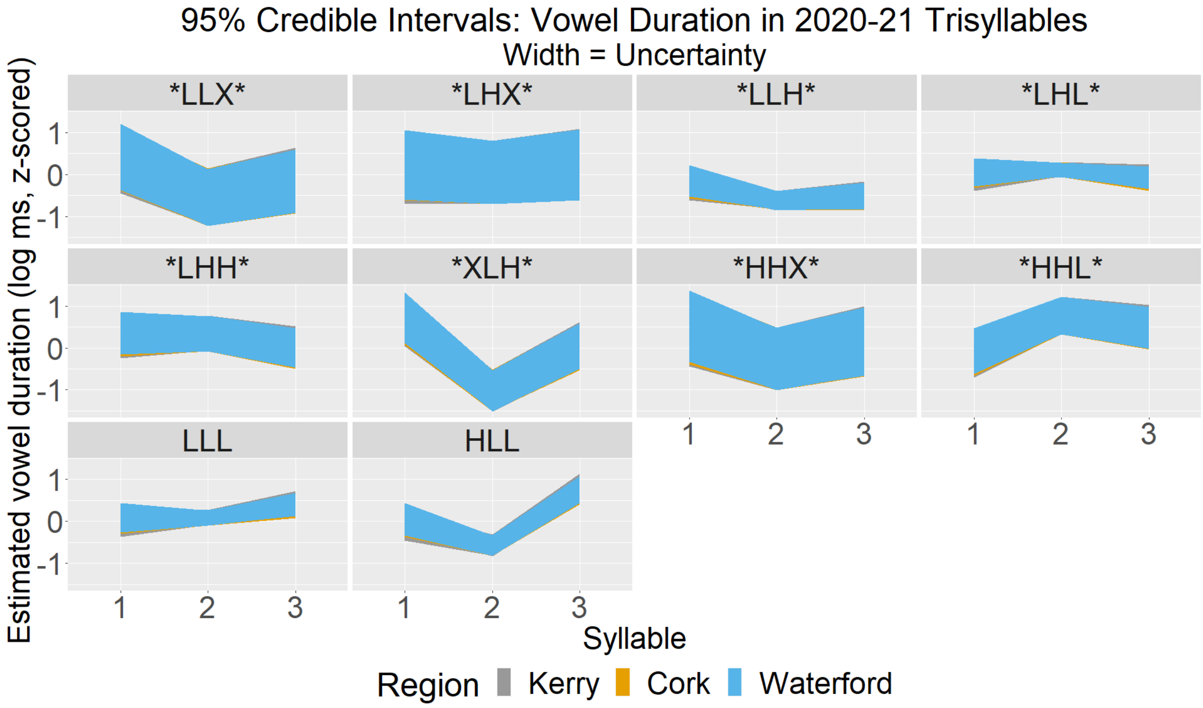

Figure 75 *95% credible intervals by weight structure for Model 16 (vowel duration in 2020-21 trisyllables).*

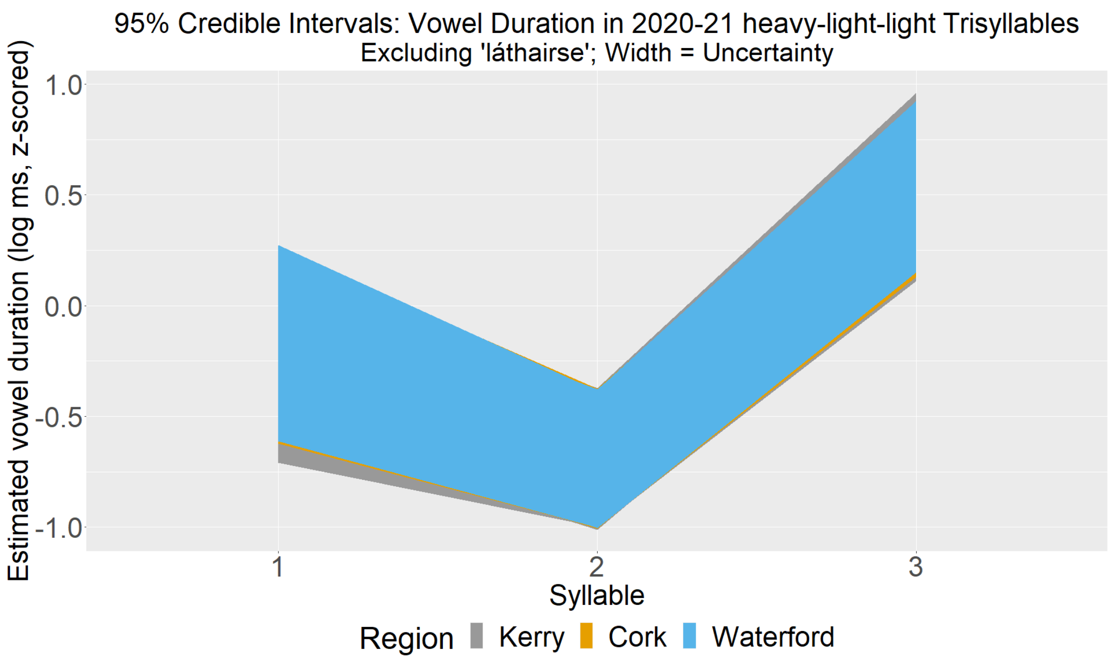

Figure 76 *95% credible intervals for heavy-light-light trisyllables from Model 16b (vowel duration in 2020-21 trisyllables, excluding* láthairse *from the data). The model's estimates are unchanged from the original Model 16 (Figure 74).*

For HLL, this final durational boost may in part derive from the overrepresentation of the word *láthairse* 'presence/place[.EMPH]', in which the emphatic suffix *-se* may receive a measure of independent focus. The impact of this particular item can be assessed by excluding it from a refined model (Model 16b). However, as shown in Figure 76, even without *láthairse* in the data, final-syllable vowels are predicted to have above-average length in HLL words. An alternative explanation for this final duration-prominence could then be a high proportion of boundary-adjacent tokens, which may experience a degree of final lengthening (as noted in discussion of Model 14). In any case, there is evidence of reduction for medial syllables in these HLL words, which are predicted with a relatively narrow range of credibility to have below-average duration. From a durational perspective, initial syllables are evidently more prominent than these medial ones, but – at least in certain contexts – are outstripped by vowel durations in final syllables.

Moving then to items with expected medial PLP in Munster (HHL, HHX, LHL, and LHX), three distinct patterns emerge in the joint posterior distribution. For HHL items, medial vowels are predicted to have above-average durations, slightly greater than the still above-average durations of final light syllables' vowels. However, initial syllables' long vowels and diphthongs are not predicted to be below average in duration; medial syllables may receive durational emphasis of some sort, but this is apparently not accompanied by durational reduction of the other two syllables. For LHL, roughly average vowel durations are predicted across all syllables. Finally, for HHX and LHX, uncertainty is very high given the scarcity of datapoints available for each category (three and two, respectively). What limited predictions the model attempts to make do not indicate credible durational prominence in medial position. For the remaining weight structures, which have PLP expected to occur in final position, there are no cases of this expectation being reflected in predictions for relative vowel duration. The nearest candidate is the medial dip predicted for XLH items, albeit with the greatest durations predicted for initial rather than final position.

Overall, Model 16 does not provide robust evidence for durational prominence in syllables expected to have non-initial PLP, with vowel duration only favouring non-initial prominence in shift-eligible HHL (RQ2). Model results are uniform across regions (RQ2a), and differ somewhat but not drastically from those of the equivalent 1928 trisyllable model (RQ2b).

Summary of vowel duration models

To summarise Models 13-16 of relative vowel duration as a function of syllable position, while increases in vowel duration occasionally align with predicted non-initial PLP, it is difficult to see this as a robust correlate of previous descriptions of Munster PLP. Further, apparent durational prominence frequently does not align with estimated positional prominence for the other three parameters considered (RQ2). Unlike for previous models of intensity (Models 1-4) and F0 (Models 5-12), model results for both eras and all subregions were remarkably consistent (RQs 2a-b).

5.3 General inferences and chapter summary

The analyses presented in this chapter have systematically explored four potential exponents of prominence – maximum syllable intensity (Models 1-4, Section 5.2.1), maximum syllable F0 (Models 5-8, Section 5.2.2), syllable F0 range (Models 9-12, Section 5.2.3), and vowel duration (Models 13-16, Section 5.2.4) – for di- and trisyllables produced in naturalistic contexts (story readings, tellings, and retellings) by L1 Munster Irish speakers in 1928 and in 2020-21. Measurements were modelled as a function of syllable position using Bayesian linear mixed-effect models, with speaker and item weight-structure as random effects. This allowed for the comparison of model estimates and 95% credible intervals for these weight-structure categories with descriptions of PLP location in previous literature on these varieties (i.e. RQ2). Of particular interest within RQ2 is evidence for or against (i) the syllable /ax/'s status as 'medium-heavy', and (ii) the presence of non-initial, non-light syllables in a word attracting PLP under certain structural conditions. Further, it was possible to examine consistency across regional subvarieties (RQ2a), and between the two eras in question (RQ2b).

The findings of the parallel analyses across all parameters, syllable counts, and era-groups are summarised in Tables 12-13 below for di- and trisyllables, respectively. For each syllable in each weight structure, there are four cells, colour-coded according to the phonetic measure to which they refer. The symbols in each cell indicates how parameter values in a syllable was estimated by the relevant model to relate to the same parameter's values in adjacent syllables. These of course represent a gross oversimplification of the findings outlined in Section 5.2, and are provided in the interest of a rough overview for quick reference. The reader is strongly encouraged to refer back to relevant subsections as needed.

Turning first to summary results for the 8 disyllable models in Table 12, in neither LX nor XX is there evidence of /ax/ being treated as somehow heavier than the preceding light syllable. F0 range is the only parameter predicted to increase from an initial light syllable to a final /ax/, but this is impossible to interpret without reference to variable estimates for F0 height. The latter is estimated to be category-insensitive in the 1928 data, and unpredictable in the 2020-21 data. Meanwhile, for intensity- and durational prominence, the results of excluding universally deuterotonic *isteach* and *amach* from consideration (Models 1b, 3b, 13b, and 15b) contradict initial indications of final-syllable prominence. Vowel duration is estimated to decrease slightly in final /ax/ syllables in both eras once *isteach* and *amach* are controlled for. Intensity prominence in the restricted models is individually and regionally variable in 1928, and decreases between initial light syllables and final /ax/ in 2020-21.

Weight Structure	DISYLLABLES							
	DOEGEN (1928)				MODERN (2020-21)			
	Syllable 1		Syllable 2		Syllable 1		Syllable 2	
LH	=	-	=	+	-	-	+	+
	*	=	*	=	=	-	=	+
LX	*	-	*	+	+	-	-	+
	*	*	*	*	=	+	=	-
XH	=	=	=	=	=	=	=	=
	*	-	*	+	=	=	=	=
XX	+	=	-	=				
	*	=	*	=				
HH	+	-	-	+	*	-	*	+
	*	=	*	=	=	-	=	+
LL	+	=	-	=	+	=	-	=
	*	+	*	-	=	+	=	-
XL	+	+	-	-	+	+	-	-
	*	+	*	-	=	+	=	-
HL	+	+	-	-	+	=	-	=
	*	=	*	=	=	=	=	=
HX	+	+	-	-	+	+	-	-
	*	+	*	-	+	+	-	-

= *Roughly equal across syllables*; +/- *Change across syllables*; * *Variable estimates*
Intensity maximum, F0 maximum, F0 range, relative vowel duration, change between eras

Table 12 *Summary of general trends in model results for four prominence measures (maximum intensity, maximum F0, F0 range, and vowel duration) taken from disyllables in the 1928 and 2020-21 data.*

Setting aside /ax/, there is cumulative evidence for final prominence in modelling of the modern data for LH items. In the 1928 data, there is generally ambiguous and roughly equivalent prominence(s) across the two syllables for shift-eligible HH, LH, and XH. Predictions for XH items technically show a change from 1928 final durational prominence to rough equivalence in the present-day, but this is not greatly reliable given the extreme paucity of XH items in the input data. Further, there appears to be greater cross-parameter concordance in modern speakers: in the evident changes between eras, the modern outcome is generally in favour of unified trends across intensity, pitch, and duration.

Turning then to the eight trisyllable models, summarised in Table 13, for no category in which /ax/ is in competition with light syllables are there uniform predictions of the rightmost /ax/ syllable receiving cumulative prominence, regardless of which era is being considered. Rather, on the basis of the available data, intensity prominence in cases of shift-eligible non-initial /ax/ (LLX, LXL, and XLX) is predicted to fall in initial position. Higher F0 maxima are only estimated to occur on a final /ax/ syllable in 2020-21 HHX, for which non-initial PLP is not predicted for the final syllable in any case. Durational prominence, such as it is, does not obviously indicate reduction of non-/ax/ syllables, or, in the case of XLX, of the initial /ax/ syllable. Instead, a shortening of medial vowels seen across the great majority of trisyllables is estimated (with reasonable credibility).

Weight Structure	TRISYLLABLES											
	DOEGEN (1928)						MODERN (2020-21)					
	Syllable 1		Syllable 2		Syllable 3		Syllable 1		Syllable 2		Syllable 3	
LLX	+	=	=	=	=	*	+	*	=	*	=	*
	*	+	*	-	*	+	+	+	=	-	=	+
LXL	+	=	=	=	=	*						
	*	+	*	-	*	+						
LXH	+	=	-	=	-	*						
	*	+	*	-	*	+						
LHX	-	=	+	=	-	*	+	*	-	*	-	*
	*	=	*	=	*	-	=	=	=	=	+	=
LLH	=	=	=	=	+	*	+	=	=	=	=	+
	*	+	*	=	*	+	=	+	=	=	+	=
LHL	=	=	=	=	-	*	=	*	=	*	-	*
	*	=	*	=	*	=	+	=	=	=	=	=
LHH	=	=	=	=	-	*	+	*	-	*	-	*
	*	=	*	=	*	-	=	=	=	=	+	-
XLX	+	=	-	=	-	*						
	*	+	*	-	*	+						
XLH							+	*	=	*	=	*
							+	+	-	-	-	+
HLH	+	+	=	-	=	*						
	*	+	*	-	*	+						
HHX	=	=	=	=	=	*	+	*	-	*	-	*
	*	=	*	=	*	+	=	+	=	-	+	+
HHL	+	=	-	=	-	*	+	*	-	*	-	*
	*	=	*	=	*	=	=	-	=	=	=	=
HHH	=	=	=	=	-	+						
	*	+	*	-	*	-						
LLL	+	=	-	=	-	*	=	=	=	=	-	*
	*	+	*	-	*	+	+	=	=	=	=	+
XLL	+	=	=	=	=	*						
	*	+	*	=	*	=						
HLL	+	=	-	=	-	*	+	=	-	=	-	*
	*	+	*	-	*	+	+	+	=	-	=	+
HLX	=	=	=	=	=	*						
	*	+	*	=	*	=						
HXL	+	=	=	=	=	*						
	*	+	*	=	*	=						
HXX	=	=	=	=	=	*						
	*	=	*	=	*	=						

= Roughly equal across syllables; +/- Change across syllables; * High variability
Intensity maximum, F0 maximum, F0 range, relative vowel duration, change between eras

Table 13 *Summary of four prominence measures for trisyllables in the 1928 and 2020-21 data.*

In terms of competition between heavy syllables, predictions frequently conflict across different parameters. For 1928 all-heavy HHH, unattested in the modern data, the rightmost heavy syllable in fact has the lowest predicted intensity after roughly co-equal initial and medial syllables, while F0 is not reliably predictable. The same is largely true of HHL, HHX, LHH, LHL, and LHX (trisyllables with a medial heavy syllable and light or /ax/ ultima): intensity prominence favours initial syllables if any, with the exception of 1928 LHH. The latter is predicted to have roughly equivalent intensity-prominence across the first two syllables, but interestingly this changes for the 2020-21 data to favour initial syllables as in the other cases. F0 may increase in height and broaden in range over the course of these items, but given predicted increases beyond medial position (i.e. continuing through the final syllable), this does not make a particularly strong case for pitch-prominence uniquely associated with the medial heavy syllable. Predictions for vowel duration once again appear to reflect shortening of medial-syllable vowels, final lengthening, or roughly average vowel durations across all three syllables.

Finally, for structures with a heavy syllable in final position (HLH, LHH, LLH, LXH, and XLH), the picture that emerges is much the same. Intensity prominence favours initial syllables, dropping off in final position in the event of a plateau with the exception of 1928 LLH, which shows final intensity-prominence. The latter, however, gives way to initial intensity-prominence in 2020-21 speakers. The same LLH category shows increased relative vowel duration in final position in 1928, changing to longer vowels in initial position for present-day speakers. The remaining trisyllable categories show either a medial dip for vowel duration, or else average values predicted across all positions. Pitch is either not obviously linked to syllable position, or else shows increases from medial position onwards.

Based on the above, there is no particularly compelling evidence for (i) a productive treatment of /ax/ as medium-heavy, nor (ii) for exclusive extrametricality of initial syllables in the presence of heavy syllables in non-initial position (RQ2). Further, in the 1928 data, model estimates often varied by region (RQ2a), suggesting that 20th century descriptions of individual varieties are not necessarily representative of a uniform 'Munster' system.

Limited evidence of intensity and/or durational prominence aligning with predicted 'Munster' PLP locations arises in modelling of the archival data (for LHX and LHH) but reduces or disappears in equivalent models of present-day data. This is of particular interest, as my hypothesis for RQ2b was that more conservative 1928 speakers would be the ones to maintain some form of initial prominence in all weight-structures, with present-day speakers more likely on a word-by-word basis to apply cumulative, English-type prominence to a heavy non-initial syllable. Nevertheless, in both eras, there are frequent mismatches between intensity-, pitch-, and duration-prominence, at least insofar as extrapolated by the models constructed (RQ2); the relationship between metrically strong syllables and high F0 is examined further in Chapter 7.

The distorting effect on model estimates exhibited by high-frequency lexical items known to have exceptional peninitial PLP in all varieties of Irish is also of note. Reversal of model predictions in purportedly ‘shifted’ categories such as LX or LLL when such exceptional (and very high-frequency) items (e.g. LX *isteach* and *amach*, or LLL *abhaile*) were excluded was striking in Model 3b, 5b, 7b, and 15b. This encourages caution in accepting the reliability of impressionistic PLP/‘stress’-*qua*-gestalt descriptions of lexical prominence, the role of specific high-frequency words and structures in which should be considered.

Notably, etymology and lexical category have been historically considered in the dialectological and philological literature (cf. Ó Sé 1989), but formal phonological ‘accounts’ tend either to ignore frequency, or to favour approaches couched in terms of sensitivity of PLP assignment to morphological derivation. In Chapter 6, a nonword production experiment attempts to capture present-day Munster Irish speakers’ default PLP pattern(s) in the absence of lexical knowledge. The task used to elicit the data – though contrived – forces speakers to pronounce phonotactically licit psuedowords largely independent of lexical and/or etymological knowledge (with the exception of possible cases of analogy between nonwords and similar real words).

6 NONWORD PRODUCTION EXPERIMENT

In Chapter 5, I presented a systematic – if preliminary – statistical analysis of the distribution of increased prominence in the domains of intensity, pitch height, pitch range, and vowel duration over syllable positions in di- and trisyllabic words produced by L1 speakers of Munster Irish in the context of story reading and retelling tasks in 1928 and 2020-21. This was carried out after I became sceptical of the nature and productivity of the rightward shift of phonological lexical prominence attributed to the Munster varieties, on the basis of an exploration of the aforementioned 1928 data from the invaluable Doegen Records.

Although presumably familiar by this point in the work, recall that Munster varieties are said to depart from the strongly initial, demarcative PLP exhibited by modern Connacht and Ulster Irish varieties (with limited lexical exceptions). Instead, PLP may occur in non-initial position when there is a heavy or /ax/ syllable within the first three syllables of a word. This has been noted as a regional characteristic (though not always fully restricted to Munster) under diverse descriptions since at least the early 19th century. Variation in such accounts includes the extent to which the phenomenon is lexically specified versus a default, productive process directly attributable to the syllable- and weight-structure of a word, the conclusiveness of 'shifted' forms versus simultaneous existence of more ambiguous or 'unshifted' forms, and speculation about the phenomenon's historical origins.

In planning the main data collection phase for the present thesis, therefore, I thought it important to obtain data on speakers' production strategies for lexical items of highly controlled segmental and syllabic structure of which they had no previous knowledge. Where Chapter 5 addressed RQ2/a-b concerning supporting evidence for descriptions of non-initial PLP in Munster, this chapter addresses RQ2c, reproduced below. Additionally, consistency across regional subvarieties (RQ2a) remains of interest.

> **RQ2c:** Do present-day MI speakers productively produce non-initial prominence in items they have never pronounced before?
> ***Hypothesis*:** Speakers are more likely to show variability in assigning prominence to nonwords than consistent patterns aligning with predicted prominence shifts.

The resulting nonword task (also known as a 'wug' test, based on Berko-Gleason's seminal 1958 study of the generalisation of nominal plural derivation in American English-speaking children) was therefore designed to see how present-day speakers[16] of the language treat PLP, relatively independent of lexical knowledge. The qualification of relative independence is worth making at the outset, given that speakers may demonstrate analogical strategies for producing nonwords in line with similarly structured items that already exist in their lexicon (Albright & Hayes 2003, *inter alios*). The results described below are therefore not intended to be interpreted as 100% representative of an entirely etymology- and lexis-blind underlying PLP system possessed by Munster Irish speakers, but rather as the (nevertheless informative) outcome of one particular strategy to approach this complex question.

The development of elicitation materials and structure of the task itself are outlined in Section 6.1, followed by discussion of annotation and error rates in Section 6.2. Statistical analysis of the collected data is presented in Section 6.3 over six subsections. The chapter concludes with a summary and discussion of general inferences in Section 6.4.

6.1 Methods and materials

The premise of the experiment is very simple, and its design is similarly straightforward. In order to test the productivity of weight-sensitive PLP assignment in Munster, participants were tasked with reading pseudo- or nonwords aloud in a carrier phrase. Consistent prominence patterns in production, or lack thereof, that emerged in statistical analysis were then compared against existing descriptions of PLP in the region and against equivalent measurements and modelling of phonetic prominences in real word data (Chapter 5).

Previous formal accounts of Munster PLP involve (i) weight structure and (ii) PLP being restricted to the first three syllables of a word. Weight is either binary or ternary, definitely contrasting light syllables (containing short vowels) and heavy syllables (containing long vowels or diphthongs), with an uncomfortable grey area for the syllable /ax/ which is said by some authors to be medium-heavy; others (e.g. Ó Sé 1989 and Kukhto 2019) do not suggest a productive third weight category, instead preferring to refer to limited non-initial /ax/ PLP on a lexical basis.

With these broad claims of weight productivity and reckoning in mind, the 36 stimuli for the nonword experiment were designed to comprise all possible permutations of light, /ax/, and heavy syllables of controlled segmental makeup for di- and trisyllabic structures. The addition of any further syllables (e.g. to look at restriction of PLP to the first three syllables in words of four or more syllables) would have produced an inordinate number of permutations – an additional 81

[16]Unfortunately, due to the constraints of time, this experiment was only possible for present-day speakers.

items – and did not seem worth the trade-off in participant patience and stamina to investigate a more marginal part of this purported phenomenon. Additionally, underived, monomorphemic items of more than three syllables are relatively rare in the Irish lexicon.

The consonant /bˠ/ and vowel /a(ː)/ were chosen to construct the elicitation materials. A stop consonant seemed less likely to lead to stumbling than a fricative, given constant repetition of the segment in the various nonwords. A velar consonant was ruled out due to proximity to /x/, with /bˠ/ selected for maximum distance from the velar place of articulation. The voiced consonant was selected over /pˠ/ to minimise coarticulation between the onset and vowel due to aspiration. Onset /bˠ/ was excluded if a light or heavy syllable was immediately preceded by /ax/ to avoid a phonotactically dispreferred (if not entirely illicit) word-internal /xbˠ/ sequence. With this in place, the di- and trisyllabic permutation of /(bˠ)a/, /(bˠ)ɑː/ and /(bˠ)ax/ yielded the 36 nonwords outlined Tables 14-15. As in Chapter 5, weight structures in these tables and subsequent figures which are eligible for non-initial PLP are marked with asterisks (e.g. light-light *baba* versus light-heavy **babá**). For the remainder of this chapter, weight structures will be referred to by their representative nonword target (e.g. *bababa* for light-light-light).

Disyllables		**LIGHT** ***-ba***	**/ax/** ***-bach***	**HEAVY** ***-bá***
LIGHT	***ba-***	*baba*	**babach**	**babá**
/ax/	***bach-***	*bacha*	**bachach**	**bachá**
HEAVY	***bá-***	*bába*	*bábach*	**bábá**

Table 14 *Disyllabic nonword stimuli comprising the nine permutations of light, /ax/, and heavy syllables.*

Trisyllables		**LIGHT** ***-ba***	**/ax/** ***-bach***	**HEAVY** ***-bá***
LIGHT-LIGHT	***baba-***	*bababa*	**bababach**	**bababá**
LIGHT-/ax/	***babach-***	**babacha**	**babachach**	**babachá**
LIGHT-HEAVY	***babá-***	**babába**	**babábach**	**babábá**
/ax/-LIGHT	***bacha-***	*bachaba*	**bachabach**	**bachabá**
/ax/-/ax/	***bachach-***	**bachacha**	**bachachach**	**bachachá**
/ax/-LIGHT	***bacha-***	**bachába**	**bachábach**	**bachábá**
HEAVY-LIGHT	***bába-***	*bábaba*	*bábabach*	**bábabá**
HEAVY-/ax/	***bábach-***	*bábacha*	*bábachach*	**bábachá**
HEAVY-HEAVY	***bábá-***	**bábába**	**bábábach**	**bábábá**

Table 15 *Trisyllabic nonword stimuli comprising the twenty-seven permutations of light, /ax/, and heavy syllables.*

All targets were presented in the carrier sentence *Cad a dúirt an* X*? Dúirt an* X*, '**Tá.**'* 'What did the X say? The X said '**Yes.**''. This was intended to allow for a very brief familiarisation with the target, but ideally not one long enough for the participant to over-think their target production. By framing the context as a question about what a person had said, the hope was to draw phrasal focus onto the answer given (i.e. *'Tá,'*), as prosodic correlates of phrase-level focus have the potential to mask default lexical-level prominence patterns (Gordon 2014 *inter alios*, see discussion in Chapter 2).

Participants (the same 12 who participated in the metronome experiment) were told to think of the nonwords as foreign governmental titles akin to the untranslated use of *Taoiseach*[17] (the Irish prime minister) and *Tánaiste*[18] (the Taoiseach's deputy) in English-language media, in order to facilitate naturalness of reading. They were further told that there was no 'correct' or 'incorrect' pronunciation of these words, and that they should produce them however they felt was most natural. Five repetitions of each target were elicited from each participant, with each of five trials consisting of the entire complement of nonwords in pseudorandom order, for an intended total of 2160 tokens (36 targets x 5 repetitions x 12 participants). A break was provided after each trial.

Within the same recording sessions as the metronome experiment (Chapter 4) and story reading/retelling task (Chapters 5 and 7), elicitation took place over Zoom, with stimuli presented on a shared screen via PowerPoint. As previously described, participants recorded themselves locally on Audacity for immediate transmission as a .wav file, with a back-up recording made of the Zoom session itself.

6.2 Annotation

Annotation of the recorded data took place using Praat, with each nonword token divided into syllables (and additional marking of syllables' nuclear vowels for measurement of duration). This process was identical to that described for real words in Chapter 5.

Tokens that were completely flawed (e.g. overt segmental errors, especially for consonants) were identified, as were tokens of questionable accuracy (largely to do with intermediate vowel qualities and quantities). Ultimately, it was decided to entirely exclude both ambiguous and flawed tokens from statistical analysis. Overall error rates are presented by participant in Figure 77.

[17] Historically referring to Gaelic chieftains, and cognate with the Welsh *tywysog* 'prince'.
[18] Historically referring to a chieftain or king's heir presumptive.

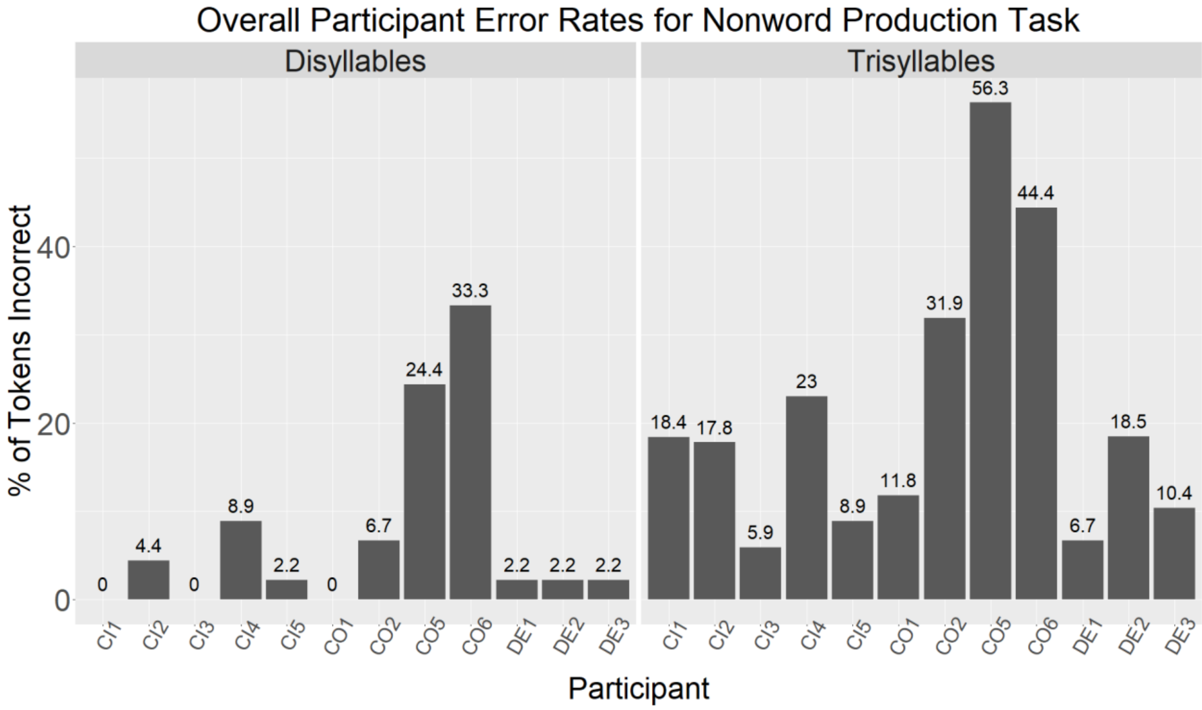

Figure 77 *Participant error rate in the nonword task for di- and trisyllables. Cork participants CO5 and CO6 showed by far the highest rates of error.*

On the whole, disyllables proved less challenging than trisyllables. Three participants (CI1, CI2, and CI3) had no errors at all for disyllables. CO5 and CO6 have the highest overall error rate for both di- and trisyllables, at 24.4% and 33.3% for disyllables and 56.3% and 44.4% for trisyllables. Subtypes of error were not labelled, but anecdotally the most common issues were addition of one or more syllables, substitution of /x/ for /bˠ/ or vice versa, and ambiguous vowel quality/quantity (e.g. [aː] for <á>, with the quality of short /a/ and the quantity of long /aː~ɑː/). Distribution of individual error rates across targets can be found in Appendix C. After exclusion of flawed targets, there was a remaining total of 1728 tokens (496 disyllables, 1232 trisyllables).

Using the same Praat scripts referenced in Chapter 5, maximum syllable intensity, maximum syllable F0, syllable F0 range, mean syllable F1, mean syllable F2, and vowel duration were extracted automatically from the annotated nonword tokens. Mean F1 (related to vowel height) and F2 (related to vowel backness) were able to be included as measures of vowel quality due to the segmentally controlled nature of the data; the variety of vowel qualities in the real-word data ruled this out for the models presented in Chapter 5. This aligns with Blum’s (2018) inclusion of vowel height and backness in her investigation of PLP exponence in a single L1 speaker of Kerry Irish.

Once extracted, raw measures were transformed in order to pool across participants, as outlined previously in Section 5.1. Intensity maxima were z-scored by participant, F0 maxima and ranges were first converted to semitones with reference to 50 Hz and then z-scored by participant, vowel

F1 and F2 means were z-scored by participant (the speaker-intrinsic formant-standardisation method proposed by Lobanov 1971, see also comparison of vowel-normalisation methods by Adank *et al*. 2004), and vowel durations were log-transformed and then z-scored by phonological length category within individual participants. All by-participant standard deviations for the interpretation of z-scores are roughly equivalent to those in Chapter 5, while for mean F1 and mean F2, individual standard deviations were roughly in the ranges 60-140 Hz and 90-460 Hz, respectively.

6.3 Statistical analysis

As reproduced above, my original hypothesis for RQ2c was that participants would show high variability in strategies for nonword prominence-assignment. However, on the basis of the real-word findings presented in Chapter 5, it seemed increasingly plausible that initial PLP would emerge as a default strategy. This would present itself as one or more phonetic prominence measure consistently favouring initial syllables. It was also expected that /ax/ would show no consistent tendency to attract prominence away from initial position. Further, it seemed probable that a good deal of variability would emerge both within and between speakers (RQ2a regarding pan-Munster uniformity), in line with lexically-specified PLP rather than a strict, weight-sensitive assignment process.

Sections 6.3.1-6.3.6 examine, in order: syllable intensity maxima, F0 maxima, F0 ranges, mean vowel F1, mean vowel F2, and relative vowel durations in di- and trisyllables. Given the near-total parallel with Chapter 5, the treatment of model construction is greatly abbreviated in the interest of perspicuity. The reader is encouraged to revisit relevant methodological explanations in Sections 4.3 and 5.2 as necessary.

For each of the 12 models presented below, random effects were specified for speaker and target nonword identities, allowing for variation in model estimates across participants and across the different weight structures elicited. Additionally, and in a departure from the Chapter 5 models, target repetition was included as a random effect to allow for possible variation in prominence-marking as participants became more familiar with each target over the course of five (non-consecutive) repetitions.

The models were supplied with weakly informative regularising priors, in line with their equivalent real-word models. Model performance was evaluated using posterior predictive checks against the input data, and the 95% credible intervals of the joint posterior distribution of estimates for the prominence parameter in question across different syllable positions were plotted by weight structure (i.e. by nonword target).

Although the latter plots of estimates and credible intervals across weight structures remain the focus of the statistical discussion, more attention is given to the basic model results than in Chapter 5. It is more tenable under the present experimental setup to consider, e.g., the general estimated effect of syllable position on a given prominence measure, given the balanced dataset and contextual controls. Plots of credible intervals for model parameters, such as those presented for the metronome data analysis in Chapter 3, are only provided for reference in Appendix C, however; their relevance is still secondary to the main by-structure plots of model estimates and credible intervals.

Finally, unlike for the presentation of results in Chapter 5, the results of posterior predictive checks have been left for Appendix C. For the real-word analysis, presentation of these posterior predictive checks served the additional purpose of providing a reference point for the relative amount of data in each weight-structure category beyond confirming the satisfactory performance of the model. Since the present nonword data are category-balanced by design, this is not required. Unless otherwise stated, all models can be assumed to have converged without issue, and to have performed satisfactorily in a posterior predictive check.

6.3.1 Maximum intensity across syllable positions

Models 17-18 examine maximum syllable intensity across initial, final, and (for trisyllables) medial position in the nonword targets produced by the 12 participants who took part in this task. As noted in Section 6.2, intensity measures were standardised (z-scored) by participant. This allowed the use of the same priors as for previous models of z-scored data (Models 1-4 in Section 5.2.1 and Models 12-16 in Section 5.2.4), namely a normal distribution with mean 0 and standard deviation 1 (truncated where relevant) for the intercept, slope(s), standard deviations, and sigma.

Model 17: Maximum intensity in disyllabic nonwords

This model considered change in intensity maxima between initial and final position in disyllabic nonword targets.

An initial inspection of the joint posterior distribution for the model (Appendix C) indicates a general preference for higher maximum intensity in initial than final syllables. The 95% credible interval for the negative estimated population-level effect of final syllable position (-0.52z) barely crosses 0 (the upper bound of credible interval being 0.07z), and the 90% credible interval is entirely clear of this null-effect point. This suggests that final syllables are likely, regardless of weight, to have lower intensity – most likely 0.5 standard deviations lower – than initial ones.

Standard deviations in estimates across speakers and repetitions are relatively restrained, with all credible intervals falling fully below 0.5z. This indicates that there is little variability in model estimates across individual participants and, within participants, across repetitions of individual targets. That is, participants tended to be consistent in their strategy for a given target. However, variability of the initial syllable intercept and the effect of final position by target structure is more pronounced, with a range of 0.55-1.36z around an estimate of 0.86z. As for Models 1-16 in Chapter 5, this is best explored using plots of 95% credible intervals by weight structure, shown for this model in Figure 78.

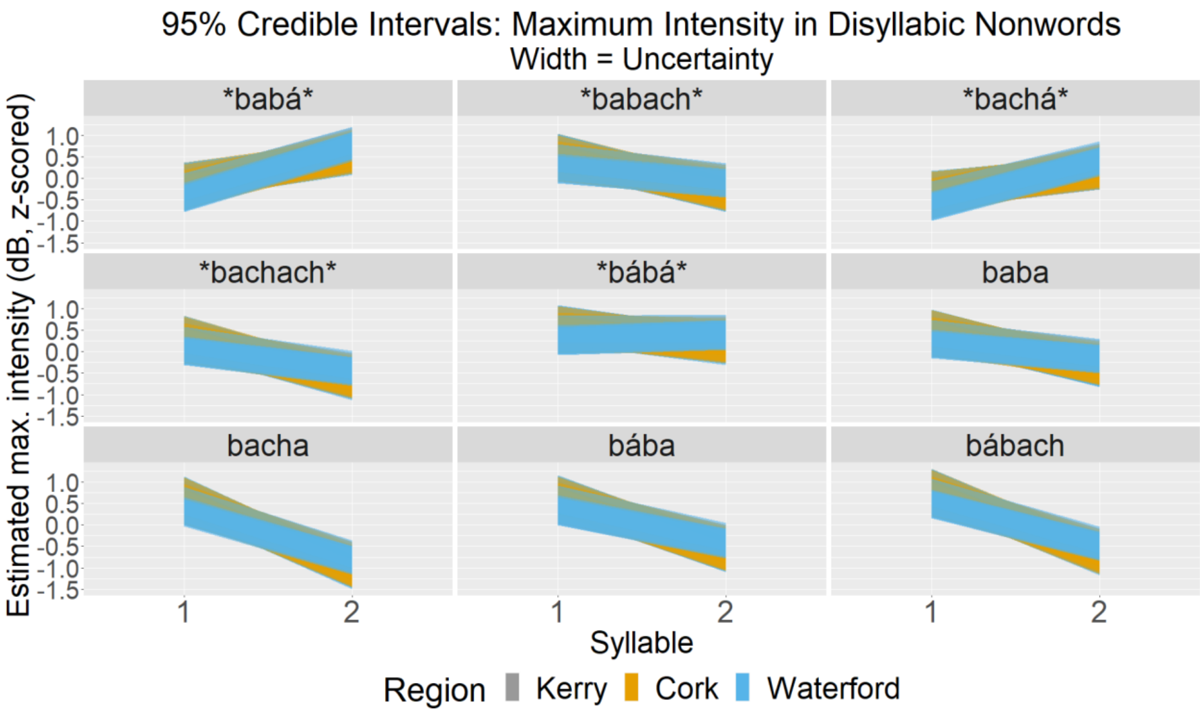

Figure 78 *95% credible intervals for Model 17 of maximum intensity in disyllabic nonwords.*

Figure 78 shows flat to negative slopes between initial and final position for seven of the nine target/weight-structure categories, i.e. predicted decline in maximum syllable intensity from initial to final position, with variance between region groups more pronounced for some categories than for others. An increase in intensity maxima height between syllables is only estimated for the remaining, shift-eligible categories *babá* and *bachá* (but note not for shift-eligible *babach* or *bachach*).

Directionality of estimated effect is consistent across regions for virtually all weight structures (except for *bábá*), with Cork and Waterford speakers diverging in terms of extremity; Waterford speakers show shallower slopes for *baba* and *babá*, versus steeper slopes for Cork speakers in *baba*, *bába*, *bábá*, *babach*, *bábach*, *bacha*, and *bachach*. Kerry speakers take an intermediate position, with predictions ranging from Cork-like to Waterford-like. Furthermore, Waterford speakers' predictions are slightly more consistent, with credible intervals for Kerry and Cork speakers exhibiting more of a 'fan' tendency. This is consistent with the dramatically higher error-rates for three of the four Cork participants, and less extreme (but still pronounced) error rates for three of the five Kerry participants. Speculation about systemic phonological differences between the two groups is difficult to justify given the relative paucity of data, although it could be argued that greater confidence in nonword reading would be consistent with a more credible default strategy for prominence assignment in Waterford.

In comparison with Models 1 and 3 of intensity in 1928 and 2020-21 real-word disyllables, a number of interesting findings emerge. For light-heavy *babá*, modern speakers produce final intensity prominence in line with that seen for real words of this structure in 1928 Waterford, Tipperary, and Clare speakers. This change for modern Cork and Kerry was also seen in the real-word data (Model 3), and was hypothesised to relate to the spread of English-type PLP which, in 1928, was restricted to the more pressured varieties of Waterford, Tipperary, and Clare. The same pattern is evident for /ax/-heavy *bachá*, which was too sparsely attested in the real-word data to be of inferential use.

For light-/ax/ items, the *babach* pattern produced (initial intensity prominence) is in line with the refined remodels of 1b and 3b that excluded high-frequency *isteach* 'inside' and *amach* 'outside', in which apparent final prominence for this category disappeared. Evidently, speakers are more likely to produce initial intensity prominence than final in light-/ax/ items – including nonsense ones which they have never said before.

Finally, in heavy-heavy items (here represented by *bábá*), while there is still no evidence of intensity prominence in final position, Waterford speakers' nonword productions are flat rather than showing the clear decrease in intensity seen in 1928 data from the region, seen in Model 1 only for now-extinct Clare Irish. Looking at modern speakers' real-word data (Model 3), nonword production is a mirror image: whereas Cork and Kerry speakers had flat to slightly increasing intensity maxima between syllables in heavy-heavy items (e.g. *cónaí* 'home'), and Waterford speakers exhibited a decline, for nonwords the opposite is the case. The cause of this is unclear, but more relevant for RQ2c is that no speaker is estimated to produce clear intensity prominence on final syllables in this weight structure, as predicted by some accounts of Munster Irish PLP.

With reference to RQ2c, these results indicate that Munster Irish speakers assign intensity prominence to final heavy syllables over initial light ones, but that this does not obtain for heavy-heavy items: *bábá* has decreased intensity maxima across syllables for Kerry and Cork speakers, and unchanged levels of intensity for Waterford speakers. It also appears that /ax/ does not attract intensity prominence away from initial light syllables in targets *babach* and *bachach* for any of the speakers or region-groups. As such, it seems reasonable to suggest that while speakers may produce final intensity prominence on certain real-word light-/ax/ items, modelling does not provide convincing evidence that they do so as a default strategy for unfamiliar nonword targets.

Model 18: Maximum intensity in trisyllabic nonwords

This model considered maximum intensity across trisyllabic targets using the same priors as Model 17. As for trisyllable models in Chapter 5, recall that syllable position has been specified as two treatment-coded dummy variables which identify a given syllable as +/-initial and +/- final. This made medial syllables (i.e. -initial and -final) the intercept.

By-speaker variability is evident in the joint posterior distribution (Appendix C), but standard deviations across speakers for both the intercept and the two syllable-position variables fall almost entirely below 0.5, with variance across repetitions even more restricted. There is also a strong tendency for initial syllables to have higher intensity than the reference second syllable (+0.49z, with 95% credible interval 0.1-0.89), while final syllables exhibit no consistent change from this reference level (+0.1z, CI -0.31-0.33). This 'macro' picture painted by the population-level effects would suggest that initial intensity prominence followed by two syllables of equal, lower intensity is the favoured pattern for trisyllabic nonwords. Target weight-structure categories vary a great deal from one another, something which is readily evident in the 95% credible intervals shown in Figure 79.

The first point of contrast in Figure 79 with the real-word trisyllable models in Chapter 5 is the increased credibility of model estimates (i.e. narrower CIs), which is evident across all categories. This is thanks to the balanced nature of the nonword dataset, versus limited attestation of low-frequency weight structures in the real-word data.

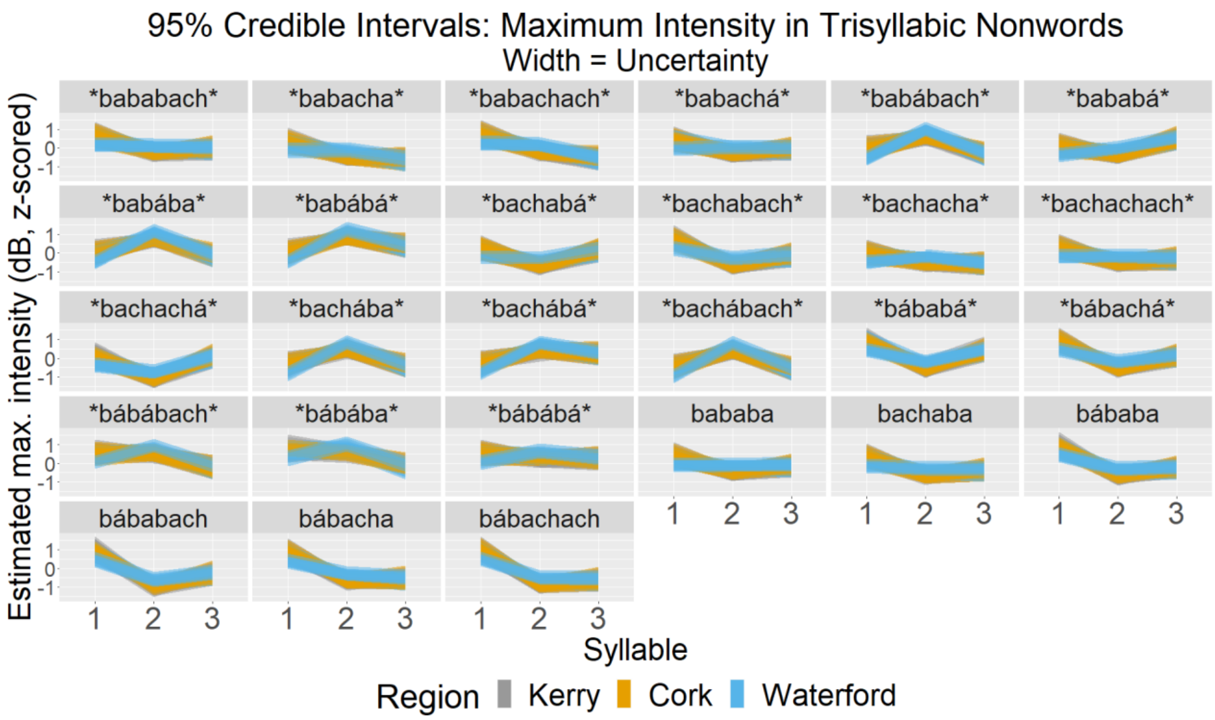

Figure 79 *95% credible intervals for Model 18 of maximum intensity in trisyllabic nonwords.*

To begin with, divergence is apparent between Waterford and Cork/Kerry participants, with relevance for RQ2a concerning regional variation. This is driven entirely by participant DE2; DE1 and DE3 conform more to a Cork/Kerry-type pattern. In cases of discord, DE2's unique pattern is for medial intensity-prominence versus initial intensity-prominence for the other speakers. For approximately 18 of the 27 trisyllabic targets, initial syllables are predicted to have a higher maximum intensity than second or third ones (consistent with the population-level estimate). Most notable among these are *babababach*, *babacha*, *babachach*, *bachabach*, *bachacha*, and *bachachach*, for all of which shift-eligible non-initial [ax] fails to attract intensity prominence for all speakers except, marginally, in medial position for DE2. Effectively, in items with no heavy syllables, intensity-prominence occurs in initial position, with the single exception of DE2's *bachacha*. The latter may be analogically driven.

Cases of final intensity-prominence are difficult to identify in Figure 79, as when a final syllable is predicted to have higher intensity than the preceding one, it is essentially on par with that of the initial syllable. DE2's *bachachá* is the only exception to this, showing credibly higher intensity maxima in final position than in either of the two preceding syllables. Heavy medial syllables exhibit credible intensity-prominence in virtually all cases for DE2, and in five of eight heavy-medial structures for Kerry, Cork, and the remaining Waterford speakers (with the exception of *bábába*, *bábábá*, and *bábábach*).

Regarding RQ2c, then, participants can be seen to produce trisyllabic nonwords with non-initial intensity prominence under certain conditions, according to one of two strategies. The first is to have higher intensity on the first heavy syllable in a word (the majority of participants), the second is to have higher intensity on heavy or /ax/ medial syllables (DE2 only). To the former majority strategy must be added that heavy syllables in final position seem ambiguous. Targets with multiple heavy syllables favour intensity prominence on the leftmost, but when the only heavy syllable is in final position (*bababá*, *babachá*, *bachachá*, *bachabá*) there is no clear final prominence.

Long vowels are expected to have higher intensity as a matter of course, casting further doubt on the prominence structure underlying targets such as *bababá* in which initial and final syllables are estimated to have nearly equal intensity maxima. Possible explanations for the observed patterns is returned to in greater detail in the chapter summary in Section 6.4, in light of results for the other prominence parameters being modelled.

Summary of maximum intensity models

To summarise Models 17-18, the assignment of intensity prominence to nonwords does appear to be sensitive to target weight-structure, but this does not fully align with the PLP patterns previously described for Munster Irish (RQ2c). Most notably, in neither di- nor trisyllables does /ax/ consistently attract prominence away from initial position. Further, although non-initial heavy syllables evidently can draw intensity prominence away from a light initial syllable, the situation is far less clear-cut for items with more than one heavy syllable (e.g. *bábá* or *bábabá*) and for cases of lone heavy syllables in final position. Most participants seem to assign intensity prominence to the first heavy syllable in a target, with model results fairly uniform across regions for this measure (RQ2a), with the exception of DE2's trisyllable productions.

6.3.2 Maximum F0 across syllable positions

These two models consider F0 maxima in terms of speaker-standardised semitones across syllable positions, in line with their real-word counterparts in Section 5.2.2.

Model 19: F0 height in disyllabic nonwords

Turning first to disyllables, in a broad, population-level inspection of the joint posterior distribution for this model (Appendix C) a decrease in maximum F0 is estimated from initial to final position. However, this is modest to the point of being nearly meaningless, centring around -0.15z from an intercept of 0.8z. With reference to participant DE1 as an example, this translates to an intercept of 25 semitones which decreases by only 0.3 semitones in final position. This is not greatly surprising, given the observation of participants' tendency toward 'flat' intonation, possibly due to (i) the repetitive nature of the task, and (ii) being instructed to place phrasal focus on the syllable immediately following each nonword target.

The lack of strong patterns in directionality or steepness of change is particularly stark when 95% credible intervals are considered target-by-target in Figure 80 below. Participants from all regions share a great deal of uncertainty (wide CIs), especially for F0 estimates in final position. Overall it seems that credible estimates for initial syllables' F0 maxima centre on a given speaker's mean, and in the second syllable this may remain unchanged, increase slightly, or decrease slightly (again bearing in mind the extremely small scale in terms of perceptually salient pitch). With the exception of some Kerry speakers, slight increases in F0 maxima can be seen in final position for shift-eligible *babá* and *bachá*, but not for *babach* or *bachach*. Recall however that such minute differences of <0.25z are equivalent to a single semitone or less.

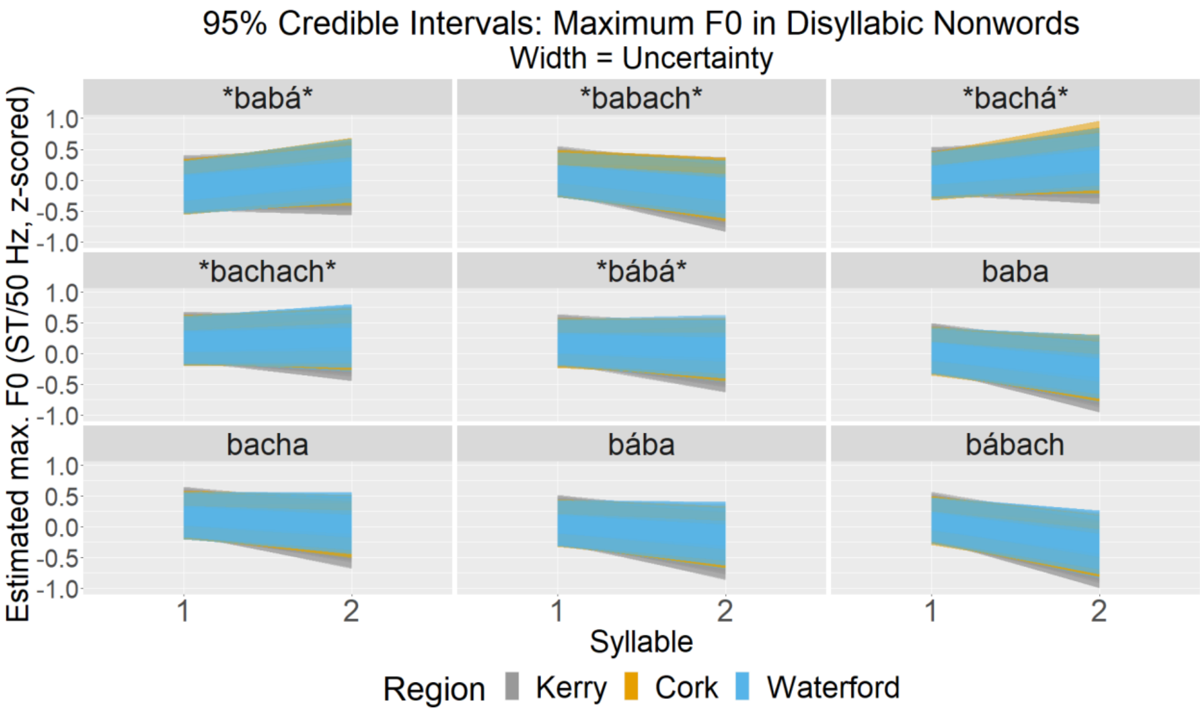

Figure 80 *95% credible intervals for Model 19 of maximum F0 in disyllabic nonwords.*

The general cross-target uniformity, or perhaps more accurately lack of evidence for strong F0 patterns for individual targets, is striking in comparison with the results for the equivalent Model 17 of intensity maxima in these same disyllabic targets. Regarding RQ2c, there is only very limited evidence of non-initial syllables receiving consistently higher (or lower) F0 maxima than initial syllables, and this is largely consistent across speakers (RQ2a). Where this does obtain, it applies only to final heavy syllables, and not for final /ax/ syllables. The relationship between this and more obviously structure-sensitive intensity results is returned to in the chapter summary (Section 6.4).

Model 20: F0 height in trisyllabic nonwords

For the model of F0 height in trisyllabic nonwords, a first glance at estimates in the joint posterior distribution (Appendix C) shows no credible effect of either initial or final position on height of a syllable's maximum F0 in contrast medial position (the model intercept). Both positions have estimated slopes of less than 0.15z. In Figure 81, it is clear that there is reasonably credible change in F0 height across syllable positions, although the range for these changes is still extremely restricted. Variation across targets in speakers' estimated patterns, however, is minimal.

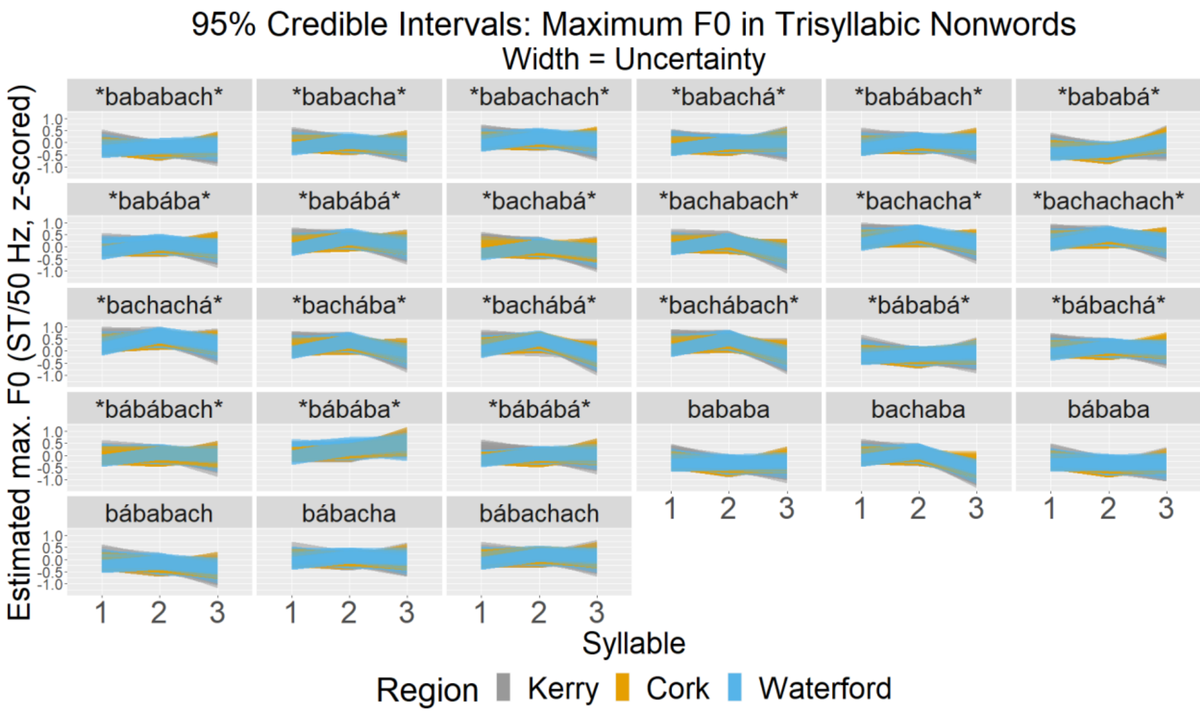

Figure 81 *95% credible intervals for Model 20 of maximum F0 in trisyllabic nonwords.*

Cork speakers apparently are relatively uniform in having a predicted V-shape for pitch across the three syllables, with variation in the relative scaling of the first and third syllables. This is shared by some of the Kerry speakers, with the remainder of predictions for this group exhibiting a global decline from initial to final syllable, with a potential plateau between the first and second syllables. The majority Cork/Kerry pattern sometimes shows slightly higher estimates in final than initial position, but this does not appear to be linked to weight structure (occurring, for example, in both *bababá* and *bábába*). Finally, the three Waterford speakers are split between DE2 with consistent medial pitch-maximum increases (as much as 1z higher than the surrounding syllables) and DE1/DE3 with a more ambiguous, Kerry-like pattern. Regarding RQ2a, this indicates greater regional/individual variation for F0 height in trisyllables than was seen for intensity.

As for Models 5-8 of F0 height in Chapter 5's exploration of real-word prominences, it is worth questioning the interpretation of higher pitch in initial and final syllables. While it is certainly possible that this represents pitch prominence (and possibly more abstract PLP), it is also conceivable that it represents a transition to or away from high pitch on an adjacent syllable. This is particularly relevant for final syllables, given the instruction to place phrasal focus on the syllable immediately following each nonword target (*Tá* 'Yes/Is'). In these cases, we may question whether these targets have received any dedicated (rather than contextually coincidental) F0 activity at all. By partial contrast, while DE1's pattern of high F0 in medial syllables clearly involves F0 activity dedicated to the nonword targets, the structure-invariance may indicate phrase-level intonation rather than lexical-level PLP marking. This interpretation is encouraged by its contrast with structure-variant intensity prominence seen in Model 18.

These results are similar to the consistent patterns of F0 maxima in various sets of real-word prominence data examined in Chapter 5, in which region- or speaker-specific pitch patterns emerged apparently regardless of item weight-structure or location of intensity prominence. However, whereas present-day real-word trisyllables in particular had model results characterised by a great deal of uncertainty, the results for nonwords produced by the same speakers are remarkably clear (on an individual-speaker basis).

Division amongst participants aside, variation in estimates within strategy-groups is evidently associated more with speakers than with target weight-structures. These results are consistent with a generic default strategy for assigning pitch-patterns to nonword targets without respect to weight structure (RQ2c).

Summary of maximum F0 models

To summarise findings for Models 19-20, neither the di- nor trisyllable model produced evidence of changes in F0 maxima linked to distribution of heavy or /ax/ syllables within a given nonword (RQ2c). Instead, results were consistent within participants across the various targets, with subgrouping evident in the trisyllable model. This subgrouping crossed regional boundaries, but nevertheless highlights that Munster speakers are not guaranteed to produce uniform results (RQ2a). Disyllable results were uninformative, suggesting no consistent F0 patterns for any speaker's productions of these targets, while trisyllable results show three clearly defined strategies for F0 movement across targets.

6.3.3 F0 range across syllable positions

These two models parallel Models 9-12 in Chapter 5 in examining changes in syllable F0 range over the course of di- and trisyllabic items – in this instance, of course, looking at nonwords rather than real words. Recall from Section 5.2.3 that inference of relative syllable prominence from local F0 range is not necessarily straightforward, but that increased syllable F0 range is broadly positively correlated with higher F0 maxima. This can be seen for the present nonword data in Figure 82 below, in which all participants show a positive correlation between F0 maximum and range in syllables.

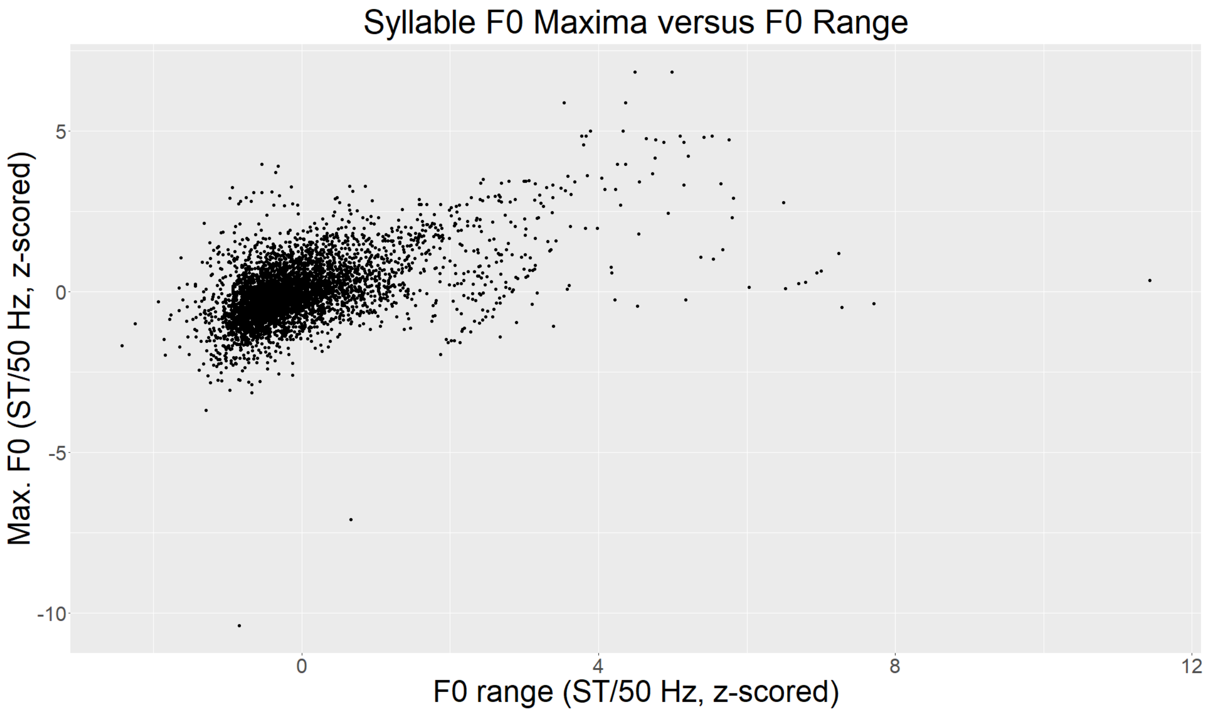

Figure 82 *Maximum F0 versus F0 range for syllables in the nonword production data.*

Model 21: F0 range in disyllabic nonwords

In the joint posterior distribution of estimates for the model parameters (Appendix C), there is no credible effect of syllable position on F0 range without taking item weight-structure into account. Variability in second-syllable estimates associated with speaker and target are both somewhat pronounced, centring on 0.33z and 0.41z respectively. This is explored in Figure 83, showing 95% CIs for syllable F0 range for each of the nine targets.

Similar to the models of F0 height across syllables, F0 range appears to have little in the way of a consistent robust relationship with syllable position across any of the target categories, and this is consistent across speakers/regions (RQ2a). With that said, there is an apparent widening of range on final syllables in targets *babá* and *bachá* which sets these results apart from the equivalent Model 19 of F0 maxima in these disyllables. In the latter, model predictions were basically invariant across targets, showing an uninformative spread of credible changes in F0 range in the transition from initial to final position.

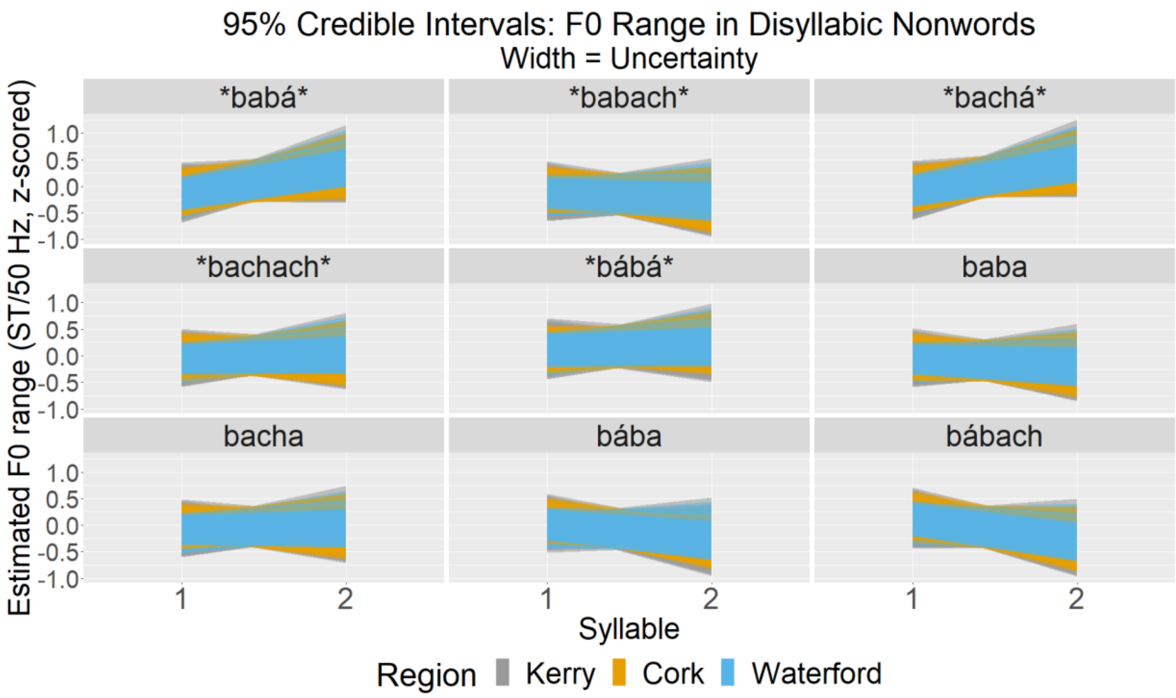

Figure 83 *95% credible intervals for Model 21 of F0 range in disyllabic nonwords.*

For this model, Waterford speakers are estimated to have wider ranges associated with final heavy syllables in light-heavy (*babá*) and /ax/-heavy (*bachá*) targets – the same items which were seen to receive marked final intensity-prominence in Model 17 (Section 6.2.1). Notably, the same pattern does not emerge for final /ax/, nor for the final syllable of heavy-heavy *bábá*, at least not with any credibly identifiable definition. However, as for the other F0 models seen thus far, this is a very limited effect in terms of actual pitch ranges.

Model 21: F0 range in trisyllabic nonwords

The next model considers F0 range in trisyllabic targets. The joint posterior distribution (Appendix C) indicates that, regardless of weight structure or speaker, medial syllables (the model intercept) will have roughly average F0 ranges, initial syllables will have slightly below-average ranges with widening in final position.

Looking at credible intervals for F0 range plotted by region-groups in Figure 84, things look very similar to results for F0 maxima in the same trisyllables in Model 20. There are two broad patterns evident, dividing speakers into those with widest F0 ranges estimated in medial versus final position.

The Kerry and majority Cork pattern is for slightly below-average F0 ranges for initial and medial syllables followed by a widening of range in final position. For Waterford and the remaining Cork speakers, cases of both range-broadening in medial position and of a gradual increase in range over the course of the three syllables are evident. Within these strategies, participants' estimates are largely consistent across targets (RQ2c).

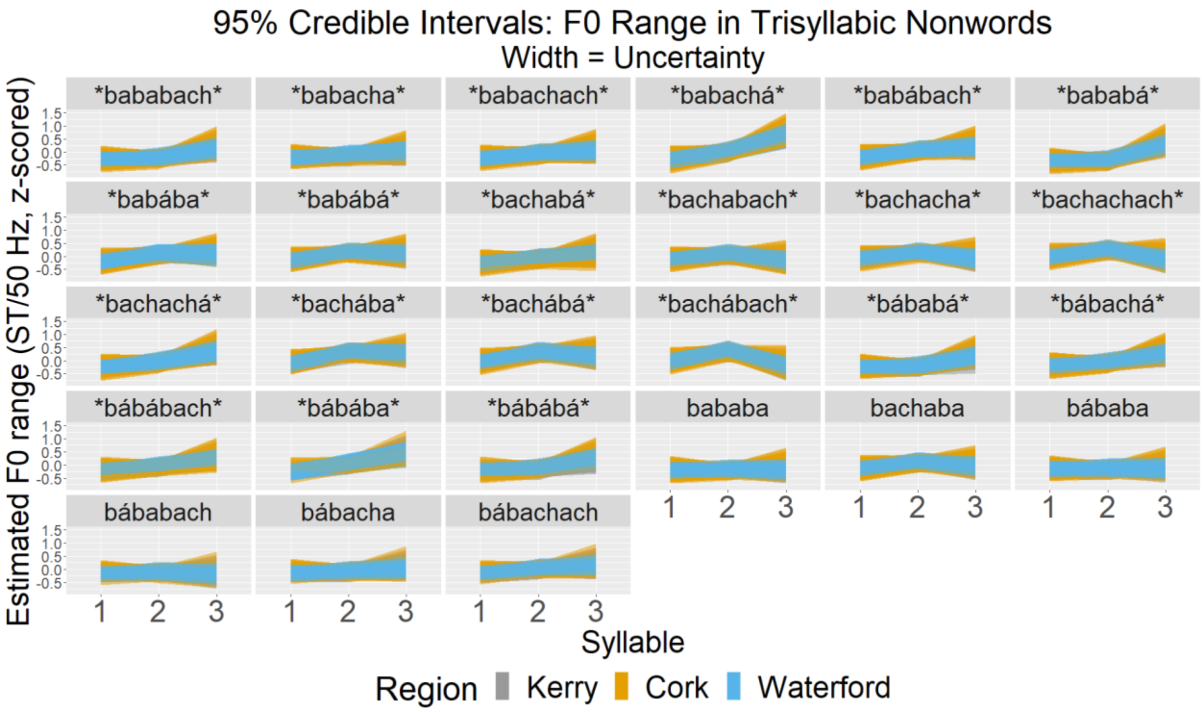

Figure 84 *95% credible intervals for Model 22 of F0 range in trisyllabic nonwords.*

Medial prominence for this measure seems reasonably straightforward to interpret (particularly in light of similar medial peaks for the same speakers in Model 20 of F0 maxima for these items): pronounced pitch movement for these items is clearly affiliated with this medial syllable, and this is further defined by average or below-average pitch measures on both its left and right margins. Whether this relates to PLP location or phrase-level intonation is unclear. The alternative climb to maximal range-breadth (and, as per Model 20, F0 height) in final position, whether gradually or sharply defined from a medial elbow, is more ambiguous.

It is possible that the latter reflect intended pitch-prominence in final position, but it is equally plausible that they represent a climb to a pitch-accent affiliated with the narrow focus placed on the syllable following the target. The pitch excursions captured by a measure of F0 range are not by any means inherently parabolic (that is, entailing a rise followed by a fall); they may just as well be (quasi)linear climbs through a syllable. The present data and models are not well suited to militate between these two options, and in a sense the ambiguity itself is of interest. Alignment between high pitch and metrically strong syllables is returned to in Chapter 7, with focus on the timing of observed F0 contours' regions of high pitch.

Summary of F0 range models

In summary, the two models of F0 range across nonwords differ somewhat from each other, similar to the results of modelling F0 height. For disyllables, there is greater interregional coherence, with wider F0 excursions in the final syllables of light-heavy *babá* and *bachá* being the most noteworthy result. For trisyllables, there is a split between Waterford and Kerry patterns, between which Cork speakers are split, with the former favouring medial pitch-prominence in a majority of cases (most clearly defined in all-light items and those with a single heavy syllable in medial position).

6.3.4 Mean F1 across syllable positions

Because of the tight controls on the nonword targets' segmental structure, an additional set of measurements not possible for the real-word data were feasible for the present data, namely measures of vowel quality. I turn first to the first formant (F1), the value of which is inversely correlated with vowel height.

As for previous sections, models were carried out by syllable count. However, results here and for mean F2 in Sections 6.3.5 are presented such that only items with uniform vowels are considered in turn, in recognition of the substantial quality distinction which supports the phonological length contrast in the Irish vowel system. As a precaution, separate models using only short-vowel items were also constructed, but the results were virtually identical to those for the combined all-short/all-long models and are therefore not reported here.

Model 23: F1 height in disyllabic nonwords

The joint posterior distribution of this model (Appendix C) indicated a weak positive effect of final syllable position on F1 height with between 50 and 60% credibility, alongside pronounced variance across levels of the random effect of target. That is, there is a marginally credible possibility that /a/ and /ɑː/ are produced lower in final syllables.

Looking at the model estimates' 95% credible intervals for the four short-vowel disyllables in Figure 85, the model estimates higher F1 (i.e. lower height) for the second /a/ of *babach* and *bachach* than for that of *baba* or *bacha*. The latter two appear to have relatively constant vowel height across syllables, with a slight lowering (increase in F1) in final position for Kerry and Waterford speakers. This provides a tentative benchmark for the relationship between /a/ height and what can be considered reduction in vowel quality, as initial PLP is strongly expected for *baba* and *bacha* (and indeed seen in Model 17 of intensity prominence in these items). If the predicted decrease in F1 between the two syllables for Cork and Waterford represent a degree of vowel reduction, we may cautiously infer that /a/-raising (F1 lowering) is associated with this process. This would be consistent with the vowel becoming less peripheral from its 'reference' position in the bottom-left corner of the vowel quadrilateral. Insofar as this holds, what is seen for *babach* and *bachach* is therefore a more peripheral /a/ position in the final syllables of these items. This would be the first piece of evidence so far in favour of any prominence measure favouring non-initial /ax/ over an initial light syllable.

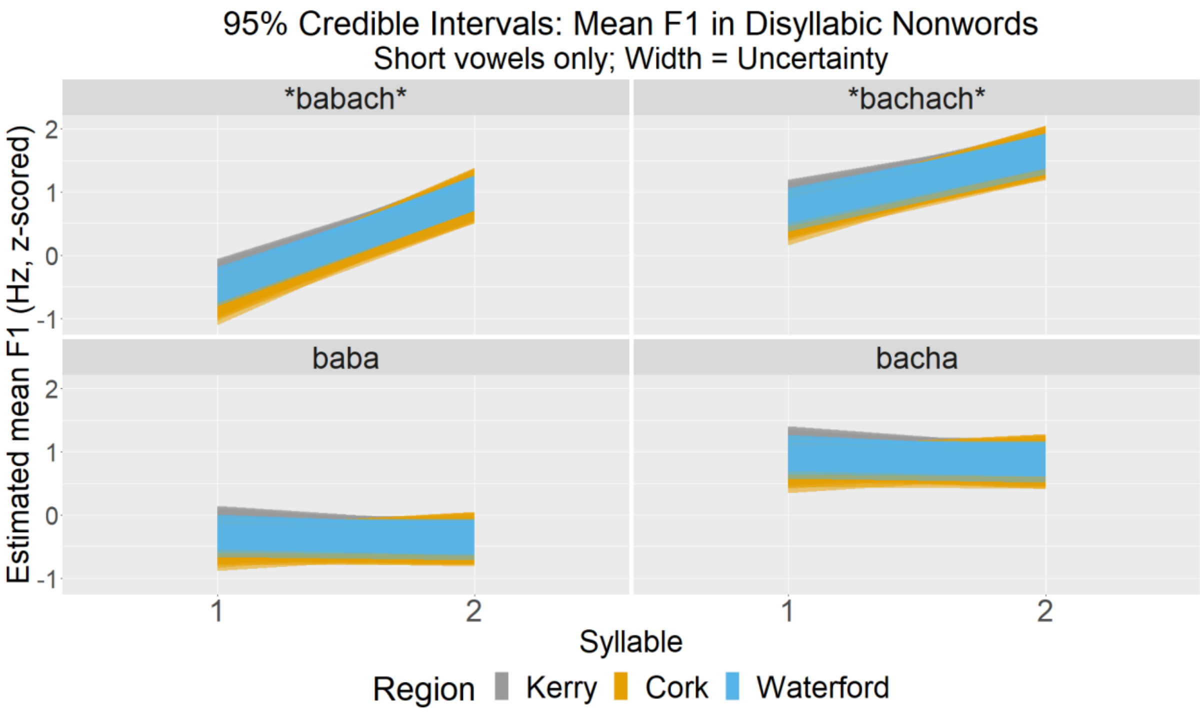

Figure 85 *95% credible intervals for targets containing only short vowels in Model 23 of mean F1 in disyllabic nonwords.*

Consider, however, F1 estimates and CIs for initial syllables (the model intercept) in these four items. For *baba* and *babach*, /a/ has slightly below-average F1 for all speakers, credibly ranging between speaker-average and 1 SD below-average. For *bacha* and *bachach*, by contrast, F1 in initial syllables is credibly above average by at least 1 SD. The contrast between initial-syllable vowel heights for light-light *baba* and /ax/-light *bacha*, both predicted to have robust initial PLP under any proposed ‘Munster’ system is noteworthy, as is the similarity between the initial syllable of *bacha* and the final syllable of *babach*.

It seems plausible that the estimated changes in F1 across these nonwords is driven not by syllable position, or by PLP, but by presence/absence of the velar fricative. All four cases of [x]-adjacent vowels (either preceding or following) are estimated to have above-average F1, while the only inter-[x] vowel (in the final syllable of *bachach*) has the highest estimates and CIs. This would be broadly consistent with greater constriction in the back of the vocal tract causing higher F1; this has been demonstrated by El-Halees (1985) for perception of uvular and pharyngeal consonants in Jordanian Arabic. The interpretation of F1 change as a marker of prominence versus as [x]-adjacent coarticulation is returned to with reference to trisyllables for Model 24 below.

Model 24: F1 height in trisyllabic nonwords

The joint posterior distribution of model parameters for F1 in trisyllabic targets – without taking into account variation by random-effect levels – suggests a general preference for slightly above-average F1 height in medial position (the intercept) but no effect of initial or final position with above-chance credibility (see Appendix C). This changes rather drastically when individual targets are considered, as evident in Figure 86 below (for short-vowel-only structures).

In general, there appears to be coherence in model results for the three region-groups, as seen for the previous Model 23. Most striking is that, as for the disyllable model (though more robustly, with leaps as great as 2z), non-initial /ax/ syllables appear to have a far more peripheral, open position than initial syllables. This is particularly evident in *bababach* and *bachacha*.

Of note by contrast to these two cases of sharply-defined non-initial vowel-height ‘prominence’ associated with /ax/, however, are the more numerous cases of plateaux in F1 height: *babacha*, *bachaba*, *bachabach*, and *bachachach*. These items do not appear to exhibit singular emphasis on a single /ax/ syllable, but rather a roughly equivalent F1 height between vowels adjacent to /x/. Further, initial syllables preceding [x] (as in *bachabach*, *bachacha*, and *bachachach*) are estimated to have higher F1 than in equivalent initial /bˠabˠ/ sequences, while inter-[x] vowels have by far the highest F1 estimates. The latter results in a medial F1 peak in *bachacha*, and a final plateau at above-average F1 values for *bachachach*.

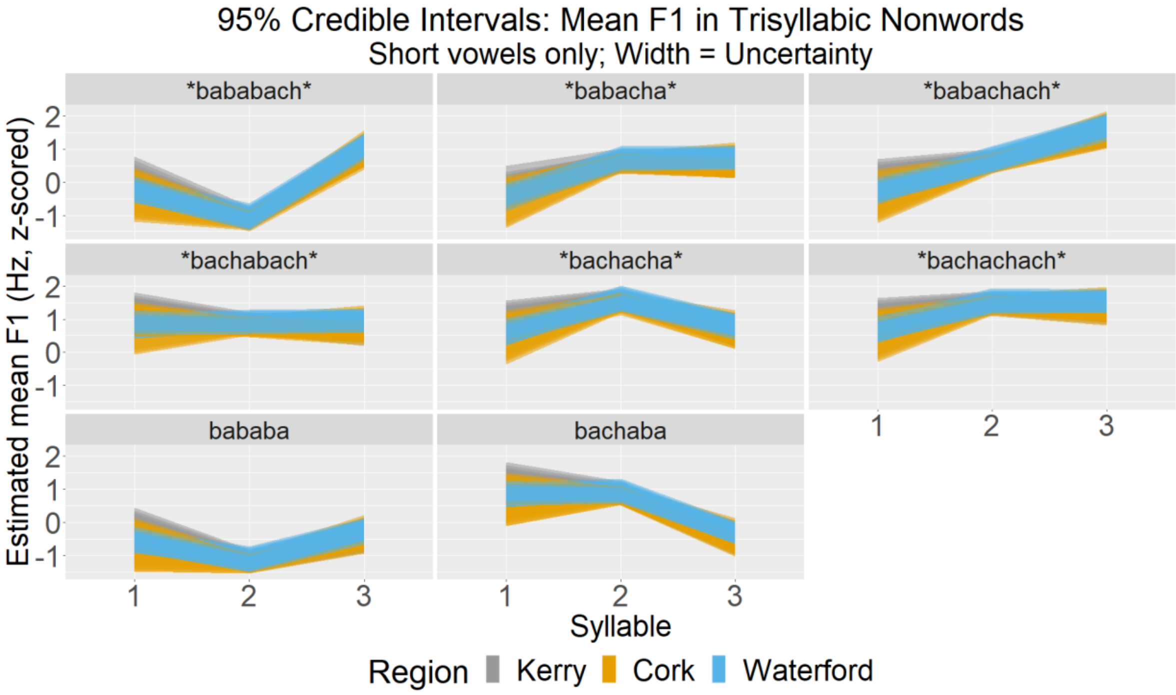

Figure 86 *95% credible intervals for targets containing only short vowels in Model 24 of mean F1 in trisyllabic nonwords.*

There is a third pattern shown only by *babachach*: a linear increase in F1 height over the course of the three syllables. This is not surprising if the distribution of [x] instances across the target is taken into account: the first vowel has no adjacent [x] and the lowest F1, the second has a single adjacent [x] and slightly above-average F1, and the third has an [x] on either side and the highest estimated F1 (2 SDs above average).

In sum, as for the disyllable results in Model 23, this model's estimates support [x] having a general lowering effect on the vowel (i.e. increased F1). This in turn fosters scepticism of F1-raising in /ax/ syllables being driven by PLP rather than by syllable-position- and weight-non-specific phonetic considerations. Regarding RQ2c, this would suggest that vowel height is not a particularly relevant measure of syllable prominence in Munster Irish, at least not for these data.

Addendum to Models 23-24: F1 height in /ɑː/-only nonwords

Finally, as noted above, it is more straightforward to consider long-only targets *bábá* and *bábábá* together rather than with their respective syllable-count groups, given the noted quality distinction supporting the long- and short-vowel length contrast. The credible intervals plotted below in Figure 87 are taken from Models 23 and 24, respectively.

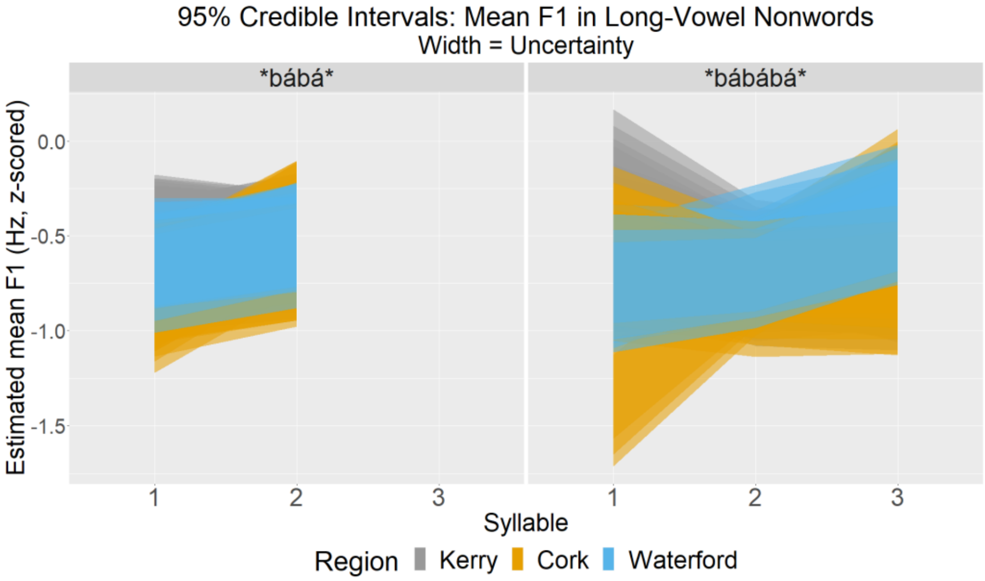

Figure 87 *95% credible intervals for targets containing only long vowels in Models 23-24 of mean F1 in di- and trisyllabic nonwords.*

Different regional subgroups appear to treat long /ɑː/ somewhat variably, perhaps related to moderate diversity in the quality of this vowel – marginally relevant to RQ2a on pan-Munster uniformity. Vowel height is below-average (i.e. less than 0) across the board for all syllable positions, which is unsurprising for low, back [ɑː].

For disyllabic *bábá*, a slight rise in F1 is estimated by the model for Waterford speakers and a minority of Cork speakers, with Kerry and the remaining Cork speakers estimated to show a slight decrease in F1 height (an increase in vowel height). These changes themselves appear to be fairly constrained.

For trisyllabic *bábábá*, there is more pronounced variation in vowel height with some regional stratification also apparent. Kerry speakers appear to lower F1 after the initial syllable, which from a peripheral [ɑː] position would be consistent with reduction/centralisation. Waterford speakers exhibit the opposite trend, suggesting perhaps a maximally peripheral vowel quality in the final syllable. Cork speakers appear to split the difference between these two options, including the possibility of unchanged vowel quality across the three positions. This does not support vowel height as a diagnostic for PLP location in syllables with /ɑː/, and by extension in these two all-heavy targets.

Summary of mean F1 models

To summarise the results of Models 23-24 for vowel height across syllable positions, there initially appeared to be a more peripheral open quality associated with non-initial /ax/ (i.e. increased F1).

However, on inspection, it seems more plausible that [x] exerts a coarticulatory lowering (F1-raising) effect on adjacent vowels than that this is a change in vowel quality reflective of final PLP (RQ2c). This is more readily reconciled with the lack of intensity- or pitch-prominence associated with these /ax/ syllables than an explanation couched in terms of /ax/-affiliated PLP expressed uniquely via vowel quality (particularly given the fact that intensity and pitch evidently *do* change over the course of these items, including at least partially as a function of weight structure). Results for the two long-vowel-only items *bábá* and *bábábá* are more diverse, and do not suggest a coherent effect of syllable position on long /ɑː/ height.

6.3.5 Mean F2 across syllable positions

In parallel to the vowel-height models of 6.3.4, this section looks at the other measure of vowel centrality/peripherality: backness. Backness is inversely correlated with the value of the second formant, such that increased F2 indicates a more front (i.e. less back) vowel quality. As for Models 23-24 in Section 6.3.4, only targets with uniform vowel qualities throughout were utilised, and although modelling was carried out by syllable-count, the model results of the two long-vowel-only targets *bábá* and *bábábá* are considered separately to their short-vowel counterparts.

Model 25: F2 height in disyllabic nonwords

Similar to the random-effect-blind view of F1 height in these same disyllables, the joint posterior distribution of this model (Appendix C) shows a roughly average F2 height for initial syllables (the model's intercept) with a weakly credible positive effect of second position (i.e. vowel-fronting in final syllables). There is pronounced by-target variance, however, particularly for the value of the intercept. 95% CIs are considered by target in Figure 88.

Credible intervals for this model are very similar to those for F1 height; there is a slight increase in estimated F2 (i.e. predicted fronting) for the final syllable of *babach*, and in Waterford speakers for *bacha* and *bachach*. For Cork speakers, there is a slight cross-syllable decrease in F2 height for *baba*. As with F1, given the strongly predicted initial PLP for light-light *baba*, it initially seems reasonable to interpret a decline in mean F2 as indicative of vowel reduction (i.e. increased backness, away from a peripheral front position). Combined with the cross-syllable decline in F1, this suggests reduction of roughly low-front /a/ to a slightly more central, less peripheral position.

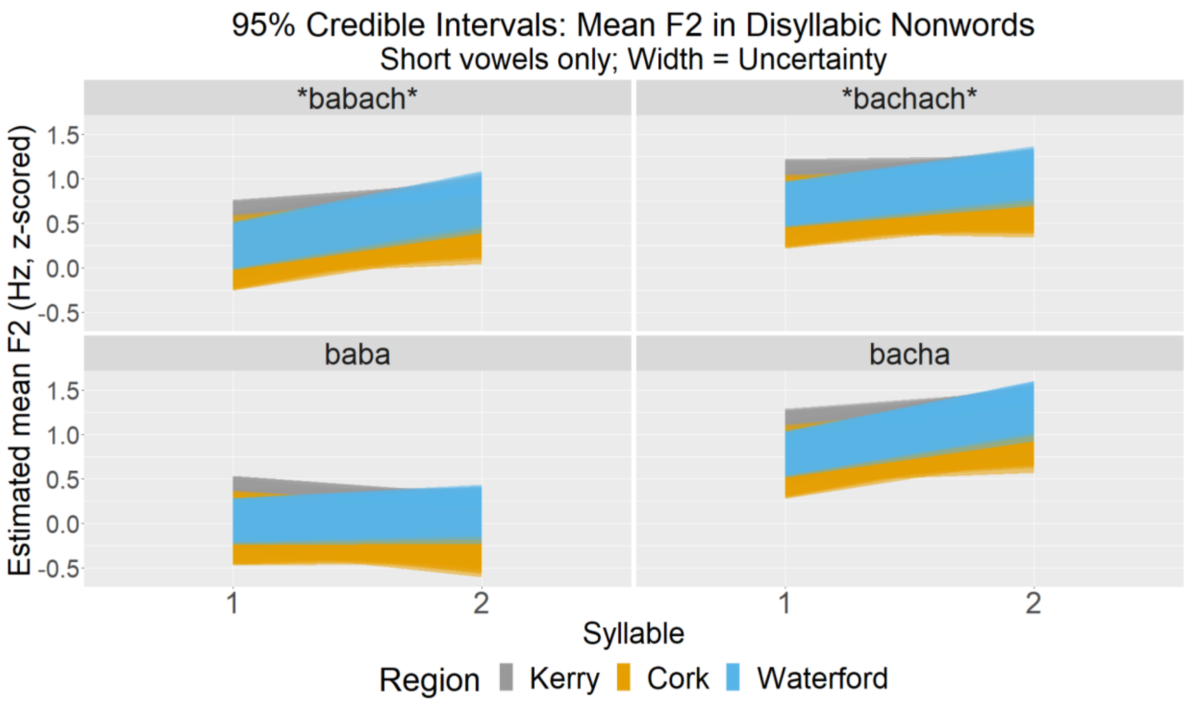

Figure 88 *95% credible intervals for targets containing only short vowels in Model 25 of mean F2 in disyllabic nonwords.*

For target *babach* (and *bachach* in Waterford), the increase in F2 height predicted for all regional groups, in combination with the raising of F1 seen in Model 23 could be taken as evidence of prominence on final /ax/. However, comparison of initial syllable estimates between *baba*-*bacha* and *babach*-*bachach* suggest that F2 is simply raised when adjacent to [x], regardless of syllable position or left- versus right-adjacency. This is consistent with the so-called ‘velar pinch’ shown by velar-adjacent vowels in which F2 raises and F3 lowers (see treatment in, e.g., Baker, Mielke & Archangeli 2008).

Model 26: F2 height in trisyllabic nonwords

Turning then to trisyllables, model results for all-light targets look similar to those for Model 24 of F1 in the same items. 95% credible intervals by target are presented for the model in Figure 89.

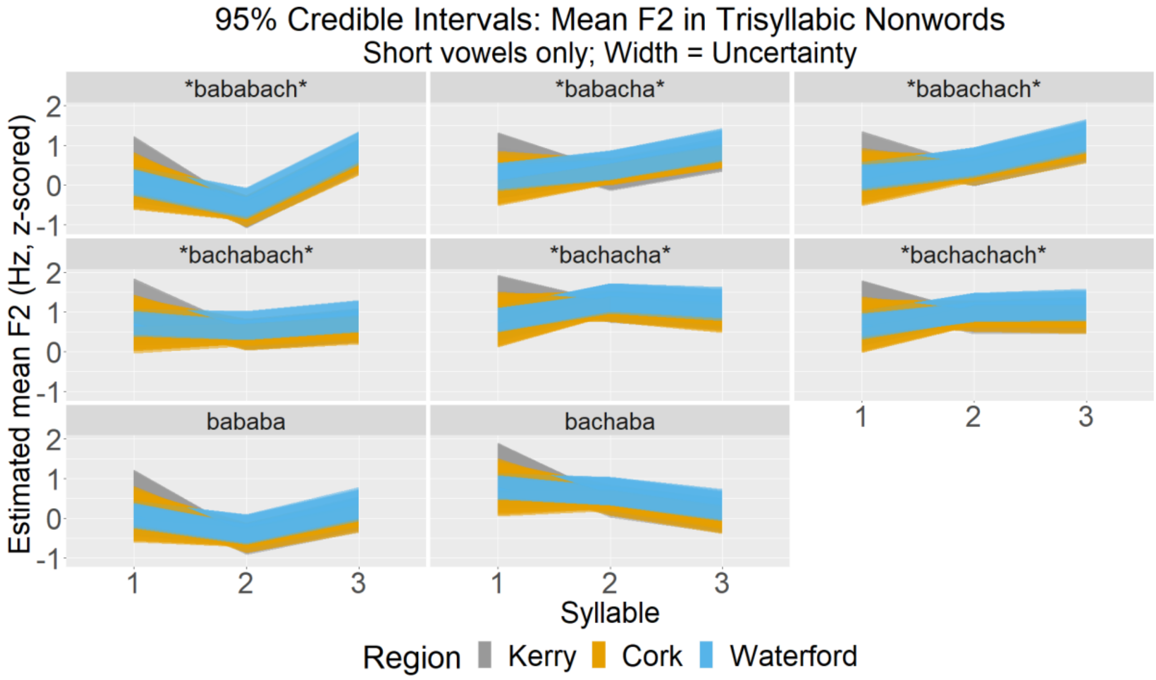

Figure 89 *95% credible intervals for targets containing only short vowels in Model 26 of mean F2 in trisyllabic nonwords.*

There is general interregional coherence in model results, with the exception of participant DE1, who appears to be consistently differentiated, as she is estimated to have higher F2 in non-initial syllables for all targets – though broadly parallel to the other two Waterford speakers after accounting for this difference.

For all speakers, increased mean F2 (decreased backness) is predicted for the final syllables of *bababach*, *babacha*, *babachach*, and *babachach*, while lower F2 is predicted for the final syllable of *bachaba*. Predictions are most uniform across speakers and regional groups for *bababa* and *bababach*, in which final syllables are predicted to have higher mean F2 than the preceding two, indicating more fronted (less reduced) /a/-realisations. Roughly the opposite can be seen for *bachaba*, in which final-syllable mean F2 is predicted to be lower than a preceding plateau in the initial and medial syllables.

The cross-positional behaviour of short-/a/ height is most straightforwardly compatible with F2 raising in /a/ when adjacent to [x], as for the disyllables examined in Model 25. Thus, regarding RQ2c, this does not support quality-marked PLP associated with non-initial /ax/ syllables, and in conjunction with a more plausibly coarticulatorily-derived contextual effect of [x] on vowel height the argument grows weaker.

Addendum to Models 25-26: F2 height in long-vowel nonwords

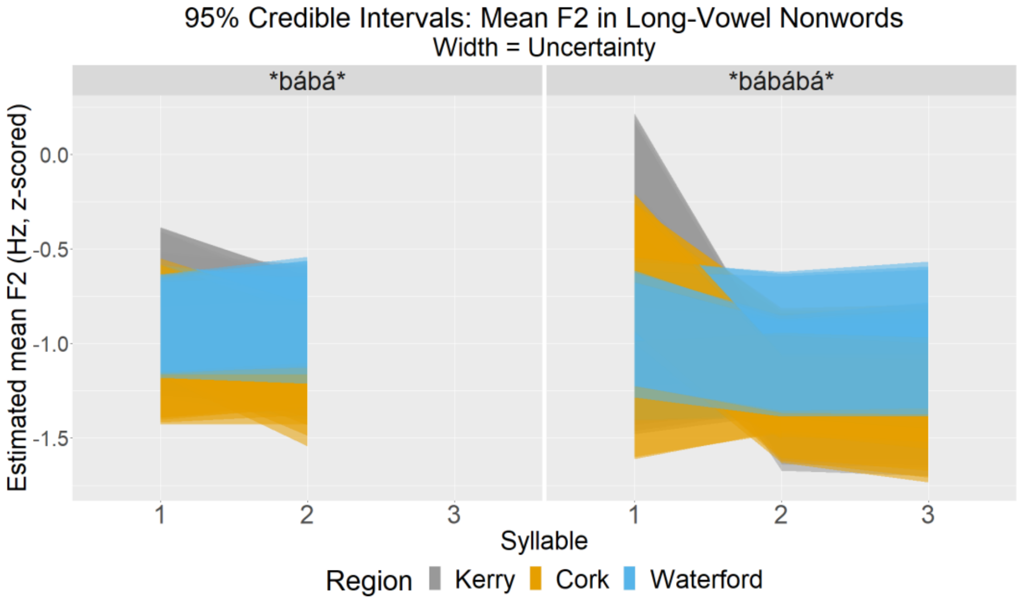

Figure 90 *95% credible intervals for targets containing only long vowels in Models 25-26 of mean F2 in di- and trisyllabic nonwords.*

For long-vowel nonwords, shown in Figure 90, there seems to be a good deal of variability in estimates across speakers and regions, especially for final syllables. This is broadly in line with what was seen for mean F1 height in the same items. In particular for *bábá*, both vowel retraction and fronting are predicted for all regions, alongside the variable height across the two syllables already seen estimated in Model 23. For trisyllabic *bábábá*, there is pronounced variability with rather wide credible intervals, especially in initial and final syllables. With the exception of estimates and credible intervals for DE1, it is generally estimated that initial syllables have a more fronted [aː] quality. Unlike for its short counterpart, /ɑː/ has a back reference quality, so this fronting suggests slight centralisation/reduction after the initial syllable rather than any sort of quality-prominence marking non-initial PLP.

Summary of mean F2 models

In summary, as for the models of mean F1 height (vowel height), these two models of mean F2 (vowel backness) do indicate positional variation in vowel quality, but this is more readily reconciled with simple adjacency to [x] than to marking of PLP on non-initial /ax/ syllables. For long-vowel targets, there is significant variability in model estimates, within which there are no grounds to claim exclusive backness-prominence (via F2 raising) for a non-initial heavy syllable in *bábá* or *bábábá*.

6.3.6 Vowel duration across syllable positions

This final pair of models examines relative vowel duration as a function of syllable position in the nonword productions elicited, paralleling Models 13-16 in Chapter 5. As in the latter four models, log-transformed vowel duration was relativised and standardised by z-scoring durations on an individual-speaker basis by phonological length-category, to yield a measure of whether a given vowel was long or short relative to its length category. Length category was also included as a random effect in these two models alongside speaker, repetition, and target.

Model 27: Vowel duration in disyllabic nonwords

At a population level, irrespective of target weight-structure, there is an apparent tendency in the joint posterior distribution (Appendix C) for disyllables to exhibit relatively longer vowels in final syllables. This is very consistent across repetitions within speakers, and relatively consistent across speakers and regions. However, considerable variability is estimated between the two length categories (around 0.5-0.7z), and across target identities.

Turning to by-target plotting of credible intervals in Figure 91, shorter final-syllable vowels are only robustly predicted across speakers and regions in *babach*. This is somewhat ironic, given the predicted location of 'Munster' PLP on final /ax/ over an initial light syllable, and further seems a more perceptually obvious reduction than the potential quality enhancements seen for these same syllables in the models of F1 and F2. It is also conceivable that shorter vowels in /ax/ syllables are tied to these being the only closed final syllables under consideration.

All speakers are estimated to have relatively high-duration long vowels in the final syllables of shift-eligible *babá* and *bachá*, although this is more pronounced for Cork and Waterford speakers than for Kerry. Above-average vowel duration in the final syllables of these two items aligns with intensity prominence predicted for the same syllables in Model 17 (Section 6.3.1), possibly lending support to the productive implementation of non-initial prominence in light-heavy disyllables (RQ2c).

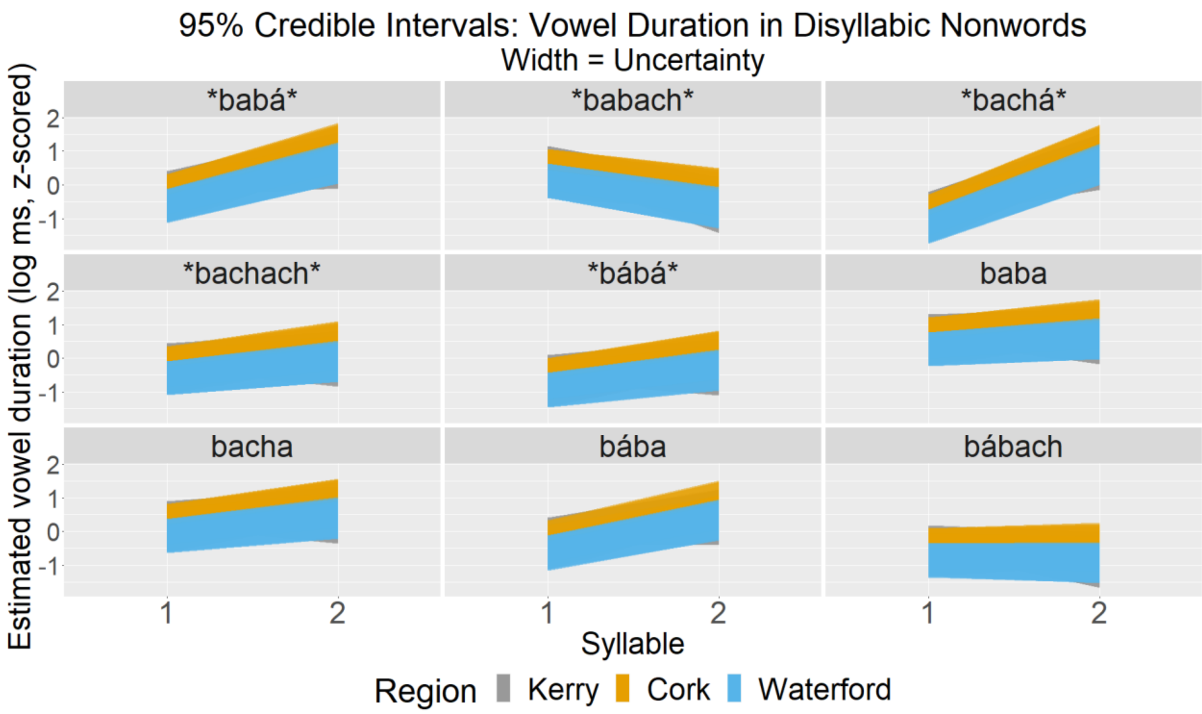

Figure 91 *95% credible intervals from Model 27 of vowel duration in disyllabic nonwords.*

There appears to be some divergence in direction of change in vowel duration estimated between initial and final syllables for Kerry versus Cork and Waterford speakers in targets *baba*, *bába*, *bábá*, *bacha*, and *bachach*, although this is largely obscured in Figure 91. In these cases, Kerry speakers show shortening of final-syllable vowels where other regional groups show slight lengthening. Such lengthening is somewhat unexpected for *baba*, *bába*, and *bacha*, as these items are not eligible for rightward PLP-shift; prominence is strongly expected on the initial syllable, as reflected in, e.g., scaling of intensity maxima (Section 6.2.1).

It is conceivable that these predictions for final non-/ax/ syllables are driven by final lengthening of some sort, but it is unclear why this does not emerge for Kerry participants; it is possible that the five Kerry speakers were less inclined to insert a pause between the nonword and the focussed final word *Tá* ‘Yes/Is’, thereby restricting the opportunity for a length-inducing boundary to emerge, but this is purely conjectural.

Model 28: Vowel duration in trisyllabic nonwords

Looking solely at the joint posterior distribution of model intercepts and slopes (Appendix C), there was a general tendency evident for final syllables to exhibit longer (relative) vowel durations than initial or medial ones, with good overall concordance across regional groups. This remained evident when plotting results by target identity in Figure 92, although some minor variation in estimates is evident across targets.

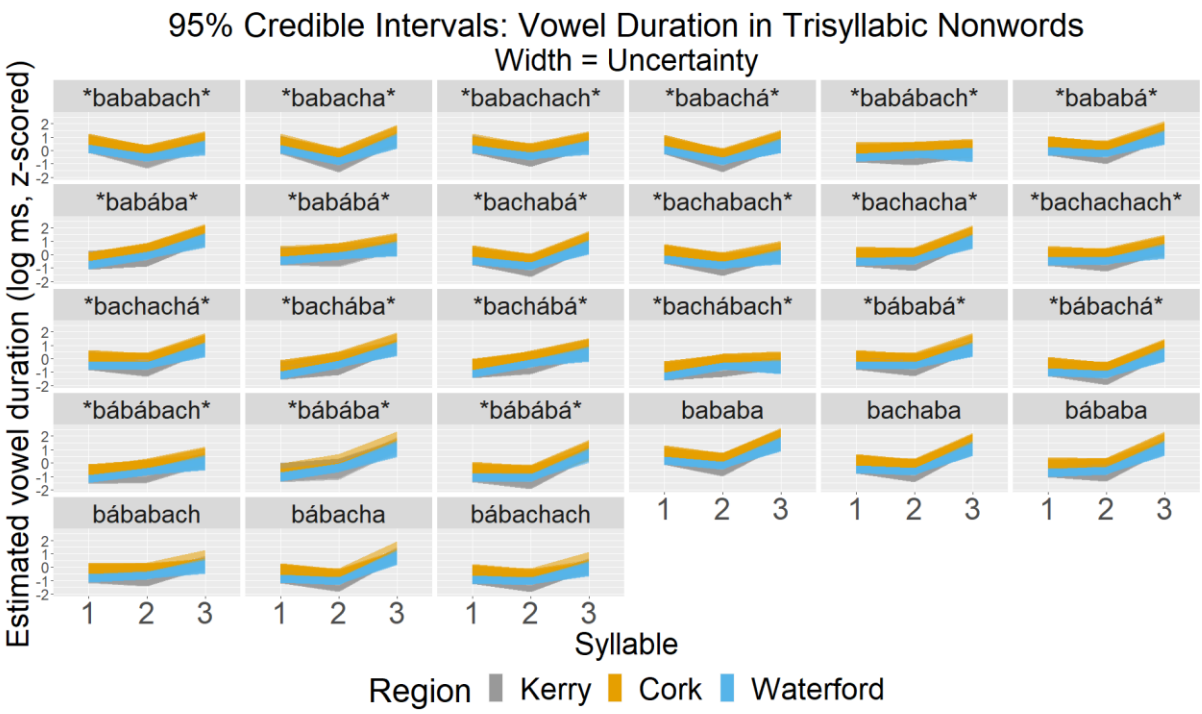

Figure 92 *95% credible intervals from Model 28 of vowel duration in trisyllabic nonwords.*

Exceptions to the general trend of average-to-short initial- and medial-syllable vowels and long final-syllable ones are the estimates for *babábach* and *bachábach*. For *babábach*, roughly category-average vowel durations are estimated across the board, with the exception of a slight medial dip for participants CI4 and CI5. For *bachábach*, this split is replicated, marginally below-average vowel durations are estimated for initial position.

Most notable is the absence of any noteworthy medial durational prominence for those weight-structures predicted to have medial PLP under a received 'Munster' model, e.g. those with a lone, medial heavy syllable such as *babába* and *babábach*. As for the disyllable vowel-duration model, the consistently-predicted long durations in final position are hypothesised to related to boundary-adjacent lengthening. As such, results of this model are not taken to provide evidence for non-initial prominence in vowel duration (RQ2c).

Summary of vowel duration models

In summary, results from the modelling of relative vowel duration across syllable positions do not show duration patterns in line with the predicted location of non-initial 'Munster' PLP. Relatively long vowels in non-initial position, generally in final position (especially in trisyllables, and of course vacuously for disyllables) seem more straightforwardly reconcilable with slight rallentando deriving from an inserted phrase boundary and/or hesitation than from non-initial PLP being productively assigned to these nonword targets.

6.4 General inferences and chapter summary

Possibly to the relief of the reader, as certainly to that of the author, this concludes the survey of phonetic prominence measures in nonwords. Over Models 17-28, this examined maximum intensity, maximum F0, F0 range, mean F1, mean F2, and vowel duration as a function of syllable position in di- and trisyllabic nonwords built from all permutations of the syllable *ba-* /bˠa/, *bach-* /bˠax/, and *bá-* /bˠɑː/. The main findings of this experiment and the associated 12-model statistical analysis are reviewed and discussed in this section.

Tables 16 and 17 provide a summary of model results for the six measures studied over syllable positions. Here each syllable receives six cells, including Mean F1 and F2. The same disclaimer made for Tables 12 and 13 in Chapter 5 applies here, namely that these tables are highly simplifying – particularly where variable model estimates by region are in question. The reader is encouraged to refer back to relevant subsections for anything more than a rough overview of prominence patterns.

Target	DISYLLABLES					
	Syllable 1			Syllable 2		
babá (LH)	-	-		+	+	
	*	-		*	+	
babach (LX)	+	*	-	-	*	+
	+	+	-	-	-	+
bachá (XH)	-	-		+	+	
	*	-		*	*	
bachach (XX)	+	*	-	-	*	+
	*	*	*	*	*	*
bábá (HH)	*	*	*	*	*	*
	*	*	*	*	*	*
baba (LL)	+	*	=	-	*	=
	+	*	*	-	*	*
bacha (XL)	+	*	=	-	*	=
	*	*	*	*	*	*
bába (HL)	+	*		-	*	
	*	*		*	*	
bábach (HX)	+	*		-	*	
	+	*		-	*	

= *Roughly equal across syllables*; +/- *Change across syllables*; * *Variable estimates*
Intensity maximum, F0 maximum, F0 range, relative vowel duration, mean F1, mean F2
Table 16 *Summary of prominence measures across disyllabic nonwords.*

For disyllables, maximum syllable intensity was broadly seen to favour final heavy syllables over initial light (or /ax/) ones, as predicted by all descriptions of shifted Munster PLP, but this did not obtain for final /ax/ in competition with initial light syllables. The only other prominence measures to consistently favour final-syllable prominence in *babá* and *bachá* were vowel duration and F0 range, but in the absence of accompaniment by consistent movement of F0 height the significance of the latter is at best vague. F0 height itself did not systematically vary as a function of weight structure. No measure meaningfully favoured final /ax/ for prominence. Decreased vowel height and backness (i.e. raising of F1 and F2) initially appeared to do so, but this is far more easily reconciled with a 'velar pinch' associated with an adjacent velar [x] than with PLP-based changes in vowel quality. The status of /ax/ is returned to for general discussion in Section 6.4.2 below.

For trisyllables, maximum intensity was the only measure to both (i) vary its prominence as a function of weight structure, and (ii) do so in line with something approaching consistency with right-shifted PLP. Subject to some individual variation, intensity prominence can be seen in Table 17 to have aligned with the first/leftmost heavy syllable in a trisyllabic target. Measures of F0 more closely resembled generic, weight-blind patterns, estimated mean F1 and F2 changes were best accounted for based on [x]-adjacency, and vowel duration heavily favoured slight medial-syllable reductions and final-syllable lengthening.

Target	TRISYLLABLES								
	Syllable 1			Syllable 2			Syllable 3		
bababach (LLX)	*	=	+	=	=	-	=	+	+
	*	+	+	*	-	-	*	+	+
babacha (LXL)	*	*	-	*	*	=	*	*	=
	*	+	-	*	-	*	*	+	+
babachach (LXX)	*	*	-	*	*	+	-	*	+
	*	+	-	*	-	*	*	+	+
babachá (LXH)	*	=		=	*		=	+	
	*	+		*	-		*	+	
babábach (LHX)	-	*		+	*		-	*	
	*	=		*	*		*	=	
bababá (LLH)	*	=		*	=		+	+	
	*	=		*	*		*	+	
babába (LHL)	-	*		+	*		-	*	
	*	-		*	*		*	+	
babábá (LHH)	-	-		+	+		-	*	
	*	-		*	*		*	+	
bachabá (XLH)	*	*		*	*		+	*	
	*	+		*	-		*	+	
bachabach (XLX)	+	*	=	=	*	=	=	*	=
	=	+	*	=	-	=	-	+	=
bachacha (XXL)	*	*	-	*	*	+	*	*	-
	=	=	*	=	=	*	-	+	-
bachachach (XXX)	*	*	-	=	*	=	=	*	=
	*	=	*	*	*	=	*	+	=
bachachá (XXH)	+	=		-	*		+	+	
	*	=		*	*		*	+	
bachába (XHL)	-	-		+	+		-	*	
	=	-		=	+		-	+	
bachábá (XHH)	-	-		+	+		*	*	
	=	-		=	+		-	+	
bachábach (XHX)	-	-		+	+		-	*	
	=	-		=	*		-	*	
bábabá (HLH)	+	=		-	=		+	+	
	*	=		*	*		*	+	
bábachá (HXH)	+	=		-	=		*	+	
	*	=		*	=		*	+	
bábábach (HHX)	*	=		*	*		-	+	
	*	=		*	*		*	+	
bábába (HHL)	*	=		*	*		-	+	
	*	=		*	*		*	+	
bábábá (HHH)	*	=	*	*	=	*	*	*	*
	*	=	*	*	=	*	*	+	*
bababa (LLL)	*	*	+	=	*	-	=	*	+
	*	+	+	*	-	-	*	+	+
bachaba (XLL)	*	*	=	=	*	=	=	*	-
	=	=	*	=	=	*	-	+	-
bábaba (HLL)	+	*		=	*		=	*	
	*	=		*	=		*	+	
bábabach (HLX)	+	*		*	*		*	*	
	*	=		*	=		*	+	
bábacha (HXL)	+	*		=	*		=	*	
	*	=		*	=		*	+	
bábachach (HXX)	+	*		=	*		=	*	
	*	+		*	-		*	+	

= *Roughly equal across syllables*; +/- *Change across syllables*; * *Variable estimates*
Intensity maximum, F0 maximum, F0 range, relative vowel duration, mean F1, mean F2

Table 17 *Summary of prominence measures across trisyllabic nonwords.*

In Sections 6.4.1-6.4.3, this chapter concludes with discussion of the above results and their implications for (i) a productive system of non-initial PLP in (present-day) Munster (RQ2c), and (ii) the existence of a uniform 'Munster' prosodic system (RQ2a).

6.4.1 Variability

Over Models 17-28, there was often variation evident across speakers and regional groups. This variability obtained not only for strategies of prominence-application, but also for general acuity in the nonword task. Turning to the latter, in terms of error rates, the Cork participants had the weakest performance as a regional whole, with CO6 being by far the most error-prone, and the only of 12 participants to have a nominal 120% error rate for one of the targets (*bábabá*). This was due to a double-repetition of the target creating six tokens instead of the intended elicitation of five, with the 'correction' itself being erroneous. Cork participants also have the highest number of 100% (5/5) error rates out of the three regional groups. Error rates are generally much higher for trisyllables than for disyllables, but the elevated Cork rate is evident in both categories.

Rate of error in nonword reading is in large part likely to be a personal idiosyncrasy. However, one might cautiously speculate about the relative strength of Irish-language dominance in the three Munster subregions. According to 2016 census data on daily Irish speakers in electoral divisions, and Údarás na Gaeltachta figures on total populations in individual Gaeltacht regions, the percentage of daily Irish users stands somewhere around 20% in each of the three regions with ~20% in each of Kerry and Cork, and ~25% in Waterford (Central Statistics Office 2022; Údarás na Gaeltachta 2022). However, this is a very blunt way of evaluating local language vitality. Equally, individual confidence and/or error rate in a nonword-reading task is a blunt instrument in its own right. Nevertheless, the high error rates for Cork speakers is rather striking in comparison with those for Kerry and Waterford; the only of the four Cork participants with relatively low rates of error (CO1) was a school principal (in an Irish-medium context).

For prominence patterns across the nonword targets, cases of individual and regional variability stand out for different measures and target-types. Regarding RQ2a, this supports moderate caution in assuming pan-Munster prosodic uniformity. However, with respect to RQ2c, it must be acknowledged that my hypothesis of total flux for application of prominence to nonwords without predictive utility of weight structure (Section 1.2 and the introduction to this chapter) is not supported, at least not in its entirety. As seen in Section 6.3.1 and summarised in Tables 16-17, participants show a clear (if slightly variable) tendency to place intensity prominence on non-initial heavy syllables, most consistently when there are no other heavy syllables in the target. F0 measures do not follow this limited weight-sensitive patterning, nor do segmental measures of duration, F1, and F2, more in line with my hypothesis for RQ2c.

Additionally, while it is possible to discuss patterns in model estimates within the bounds of their estimated credibility, it is important to underscore what is in question in these depictions and descriptions: on the basis of the data, priors, and model specifications, it is 95% credible that the 'real' value of a given prominence measure in a given syllable position for a given weight structure will fall within the plotted boundaries. It is important to bear in mind that within the plotted intervals, there is often a great range in credible slopes between syllables; even many of the apparently angled predictions in fact contain sufficient overlap between credible intervals for each syllable for a flat line to be well within the 95% credible range. As such, I am inclined to interpret even the seemingly more robust patterns in cross-syllabic prominence measures as estimated tendencies, rather than categorical rules of prominence-placement.

6.4.2 Behaviour of /ax/

In stark contrast to what is often described in accounts of PLP placement in Munster Irish, speakers do not appear to treat the syllable <-(e)ach> /ax/ as having medium-heavy weight. In virtually no cases did /ax/ attract intensity- or pitch-prominence away from initial position. For measures of vowel quality, it is possible that reduction is less likely for /x/-adjacent vowels, but this seems to apply to /xa/ sequences as well as /ax/. Whether this is phonetic or phonological is difficult to determine on the basis of the available data.

Comparison of both F1 and F2 credible-interval plots with those for intensity and pitch measures show little correspondence between the two, which would be more consistent with some contextual phonetic effect of the velar fricative on vowel quality than with PLP-based phonological reduction. Vowel duration, similarly, does not provide convincing evidence of exceptional attraction of prominence to non-initial /ax/; shift-eligible disyllables *babach* and *bachach* show vowel duration as roughly equal between syllables or declining slightly, and trisyllables appear to show a final-lengthening effect independent of weight structure.

Thus, regarding RQ2c, while there is evidence of Munster Irish speakers productively applying non-initial PLP under certain conditions, they do not appear to treat /ax/ as anything other than a light syllable. This is consistent with results for real words in Chapter 5 which indicated that apparent final prominence in light-/ax/ words was driven by the high-frequency items *isteach* 'inside' and *amach* 'outside', known to have lexically-specified final PLP in all varieties of Irish.

6.4.3 Prominence types and PLP domain

As noted, prominence is evidently possible on any of the first three syllables of a word, although it was not feasible to test the limits of this; the permutations of weight-categories for tetrasyllables were excessive for the purposes of the current task. Having established some baseline information with reasonable credibility concerning a binary vs ternary weight-hierarchy and tendencies within di- and trisyllables, a follow-up study may be able to either prioritise tetrasyllables or include a smaller range of di- and trisyllabic targets.

Speakers clearly produced both intensity- and pitch-prominence on non-initial syllables, but only the former is taken as likely to represent PLP location given the structure-invariance seen in F0 patterns. One Waterford speaker (DE2) was seen to prefer intensity-prominence on a heavy or /ax/ second syllable, regardless of first- or third-syllable weight. All remaining speakers are predicted to default to the leftmost heavy syllable (including in initial position). This divergence is most obvious in targets *bábába* and *bábábá*, in which the syllable intensity model estimates peninitial prominence for DE2, but initial prominence for all other speakers. The two groups overlap in the case of *babábá*, in which the second syllable is also the leftmost.

For F0, meanwhile, modelling shows patterns insensitive to weight structure. This was moot in disyllables, for which no clear positional estimates emerged, but positional variation emerged in trisyllables. For these, Waterford speakers tended to show a medial peak in height and range, while Cork and Kerry speakers had more pronounced pitch height and range in final position (possibly in transition to a following high target).

In practical terms, the above meant that in some cases, pitch- and intensity-prominence aligned, but frequently diverged. With the added layer of vowel duration, it is clear that suprasegmental prominence exponents do not neatly converge on a single, predictable position. This is important, given previous reliance on impressionistic identification of PLP by listeners with a non-Irish (typically English) L1 in which culminative PLP is multiply signalled by intensity, pitch, and duration; Welsh penultimate PLP with frequent pitch-prominence realisation on the ultima comes to mind in particular. In the final analysis chapter below, there is an investigation of the alignment of high pitch with metrically strong syllables in the interest of beginning to address these prominence-exponent divergences at the phrasal level using naturalistic data.

7 INTONATION INVESTIGATION

On the basis of the findings for real- and nonword prominence patterns presented in Chapters 5 and 6, and previous suggestions in the literature that the apparent PLP ‘shift’ in Munster Irish derived historically from high pitch occurring one or more syllables after PLP (Blankenhorn 1981; Windsor *et al*. 2018), it was decided to examine intonation in the available storytelling data from Munster Irish speakers in 1928 and 2020-21.

Unlike previous, Autosegmental-Metrical examinations of intonation in Munster varieties, it is not my aim to sort F0 contours into discrete pitch-accent categories (e.g. H*+L or L*+H), and this is important to emphasise from the outset. In the first place, the available data are not really suited to a comprehensive description of the historical or modern Munster pitch-accent inventory. From the perspective of tractability, it was simply not feasible to collect controlled data on intonation across different sentence modes and contexts in addition to the extensive – and, for participants, tedious – collection of data on prominence and rhythm. Second, in light of the questions raised by investigation of lexical prominence and the reliability of impressionistic identifications of PLP location in Chapters 5-6, it is difficult to justify the assignment of AM-style (e.g. ToBI or IViE) labels to F0 contours in the data without more fine-grained interrogation of the relationship between pitch events and other types of suprasegmental prominence.

Instead, it was decided to restrict the intonational investigation to the rough description of contour-shapes with a particular emphasis on the timing relationship between regions of increased F0 and intensity-prominence. These are encapsulated in RQ3, reproduced below from Section 1.2. As for Chapter 5, variation across Munster subregions (RQ3a) and between the 1928 and 2020-21 data (RQ3b) are of interest.

> **RQ3:** Does high F0 in intonation contours align with metrically strong syllables?
> ***Hypothesis*:** High pitch often occurs one or more syllables following metrical strength.
>
> > **RQ3a:** Is intonation (including alignment) consistent across Munster subvarieties?
> > ***Hypothesis*:** Regional varieties differ from one another.
> >
> > **RQ3b:** Has intonation (including alignment) changed between 1928
> > and the present day?
> > ***Hypothesis*:** Present-day speakers exhibit more influence from English prosody.

The phonological structure of the contours being described is not strictly at issue, nor is the general validity of an AM approach to intonational analysis. Further, unlike for Chapters 4-6, statistical testing and modelling did not seem appropriate, given the extremely preliminary exploratory nature of the work, which prioritises the organisation and description of the available intonation data. Rather, the present, sketch-descriptive intonational study is intended to lay the groundwork for bottom-up study of Irish intonation in and beyond Munster going forward. The analysis of the timing of high F0 relative to nearby heightened intensity is relevant for the hypothesis of high pitch which occurs after metrically strong syllables being misperceived/reanalysed as a change in PLP location by listeners (and scholars) with a non-Irish L1 – or indeed by speakers with growingly English-influenced prosodic systems – independent of the phonological representation of such high pitch. Whether such 'late' high pitch is the tail of L*+H or the head of H*/H*+L is simply not relevant at this juncture, although it may well be for future work.

The remainder of this chapter is laid out as follows. The storytelling data, familiar from Chapter 5's examination of real-word lexical prominence, are (re)introduced in Section 7.1 along with a practical outline of the chosen methods for analysis. Section 7.2 discusses the distribution of the intonation data across sentence modes and the shape/timing categories identified in 7.1. Results for prenuclear and nuclear[19] contours are presented in Sections 7.3 and 7.4, respectively. The chapter concludes in Section 7.5 with a summary of findings and a discussion of general inferences to be drawn from them.

7.1 Methods and materials

The materials for the present intonational analysis comprised the story reading and (re)telling recordings available from the 1928 Doegen Records and recorded in 2020-21 as part of data collection for this thesis. The 1928 dataset contains 26 recordings from 20 male speakers, who ranged in age at the time of recording from 36 to 82. These speakers were L1 speakers of the Munster Irish varieties of Kerry (6), Cork (6), Clare (3), Waterford (4), and Tipperary (1). The 2020-21 equivalent contains one reading and one retelling of the short story *An Mac Scaiptheach* ('The Prodigal Son') for each of 14 participants (11 female, 3 male), who ranged in age from 20 to 79. These were L1 speakers of the Munster Irish varieties of Kerry (5), Cork (6), and Waterford (3); the varieties of Clare and Tipperary recorded in the Doegen Records have not survived into the 21st century. Relevant information for both 1928 and 2020-21 speakers was previously outlined in Tables 6-7 in Section 5.1, should further reference be required.

[19]Recall from Section 2.4 that this terminology has been retained from British School and AM usage to distinguish the final F0 contour in an intonational phrase ('nuclear') from those preceding it ('prenuclear').

Annotation of the intonation data was carried out using the Points, Levels, and Ranges (PoLaR) transcription system of Ahn, Veilleux, Shattuck-Hufnagel, and Brugos (2021). This decision was motivated by PoLaR's multi-layered approach to transcribing intonation, while remaining largely agnostic about the phonological specifications underpinning the described contours. As emphasised in this chapter's introduction, my interest in examining alignment of high pitch with syllabic material is about just that, and its potential perceptual consequences, rather than in whether that high pitch is, e.g., the tail of L*+H or the head of H*+L. The methods for carrying out a PoLaR analysis are outlined in the remainder of this section, including a list of operational guidelines (p.223) and a representative example spectrogram and TextGrid (Figure 91). To my knowledge, this is the first turning-point analysis of intonation in any Irish variety.

Four tiers of information are required in a PoLaR analysis. First, the vowel midpoints of 'prosodically strong' syllables ('PrStr') are labelled with <*>, with the criteria for making this strength-determination left as a matter for the individual researcher. Ultimately I identified PrStr on the basis of intensity prominence, informed by the results of the real-word and nonword lexical prominence investigations in Chapters 5 and 6. Findings in these chapters indicated sensitivity of intensity prominence (maximum syllable intensity) to item weight structure, in line with some predictions for Munster-type non-initial PLP. F0 measures (both height and range) and vowel duration were not seen to vary as a function of weight structure, nor were mean F1 or F2 in the nonword task. On this basis, intensity prominence has tentatively been selected as the most reliable diagnostic for lexical prominence. For the identification of PrStr in a PoLaR transcription of intonation, intensity has the added benefit of not requiring reference to F0 as a prominence-diagnostic. In examining timing of high F0 relative to PrStr syllables, the latter would run the risk of equating high or low pitch with rhythmic prominence.

After identifying prosodically strong syllables, the turning points (TPs) which define a given F0 contour are labelled with <0> on a separate tier. This is distinct from claims of the number or location of phonological tonal targets, although it certainly may overlap. Rather, TPs are those points which would be required to approximate the relevant contour in (re)synthesis. The latter can be carried out using the PoLaR plugin for Praat to examine accuracy of TP-based descriptions where necessary. For present purposes, it was decided that no contour should have more than six TPs. Exceeding this maximum was taken to indicate that either (i) the movements in question were complex enough to actually comprise two adjacent contours (e.g. one 3-TP contour and one 4-TP one, rather than a single one of 7 TPs), or (ii) one or more of the specified TPs was surplus to requirement (representing, e.g., a microperturbation in F0 caused by segmental context). If a given TP is for whatever reason unreliable for automatic F0 identification, an approximation of its F0 value can be specified, e.g. <0,150> for a TP of approximately 150 Hz instead of simple <0>. The

PoLaR plugin for Praat uses these manual specifications for the level calculations described below when a lack of reliable F0 tracking would otherwise produce an error.

Third, a local F0 range is specified for a given utterance, once again on its own tier. This range is then used for the automatic calculation of discrete 'level' values for each TP on a fourth tier, with the default number of levels (5) used for the present analysis. Level calculation divides a given F0 range into equal portions corresponding to the number of levels selected, and then assigns each TP falling within the time-boundaries for which said F0 range has been specified a level equivalent to the portion of the range appropriate for its F0 value. For example, consider five TPs of, in chronological order, 105 Hz, 107 Hz, 123 Hz, 121 Hz, and 90 Hz falling within a timespan specified to have a PoLaR F0 range of 90-125 Hz. Under a default five-level system, this range has 'levels' of roughly: 90-97 Hz (1), 98-104 Hz (2), 105-110 Hz (3), 111-117 Hz (4), and 118-125 Hz (5). The five TPs would thus be assigned a level corresponding to their frequency in Hz: 3 (105 Hz, falls within 104-110 Hz), 3 (107 Hz, falls within 104-110 Hz), 5 (123 Hz, falls within 118-125 Hz), 5 (121 Hz, falls within 118-125 Hz), and 1 (90 Hz, falls within 90-96 Hz). In other words, two mid-range points which rise to a two-point high plateau and fall to a range-minimum low F0 (3-3-5-5-1).

This step is somewhat murky, something readily acknowledged by the developers of the PoLaR system (Ahn *et al*. 2019, 2021). It requires the identification of a relevant timespan for range-specification, whether over an entire utterance, phrase, or sub-phrasal constituent. The levels themselves, once calculated, are of limited but distinct utility; they present a broad, scale-independent sense of pitch-contour shapes, which allows for the identification of recurring patterns in the data. There are also other ways of accounting for pitch range while not entirely factoring out scaling considerations. For example, in order to graphically depict contours in Sections 7.3-7.4, TP F0 height was converted to semitones with reference to 50 Hz (as for lexical-level F0 information in Chapters 5 and 6) and then z-scored by participant.

In general, ranges were specified for the longest timespans possible without causing same-level calculations for pitch events salient enough to be labelled. When this occurred, especially in the early stages of annotation, F0 ranges were subdivided and relevant levels recalculated. To reuse the above 5-TP example, if a range of 50-250 Hz had been specified on the basis of F0 minima and maxima over a longer stretch of the utterance in question, the sequence of 105 Hz, 107 Hz, 123 Hz, 121 Hz, 90 Hz would be assigned levels of 2-2-2-2-1 (with level 2 spanning 91-130 Hz). This would obscure the shape of the contour being described, giving the impression of a long plateau in which two intermediate 'turning' points have been vacuously specified. For measurement of F0 contours' timing of high pitch relative to metrically strong syllables, this would also affect where said high pitch region is estimated to begin (i.e. at the first or third TP).

To summarise, a PoLaR annotation requires the specification of (i) metrically strong syllables ('PrStr') labelled at the vowel midpoint, (ii) turning points in the F0 contour, and (iii) F0 ranges within defined timespans. The bespoke operational guidelines used to annotate and extract intonation data for the present analysis are outlined below. Extraction was carried out using a custom Praat script (Rodgers 2022), which also provided TP pitch standardised as a z-score within the global F0 range in a given recording and TP time normalised with reference to contour duration and location of the metrically strong syllable midpoint.

1. Basic PoLaR steps**: PrStr**, **Points**, **Levels**, **Ranges** tiers
    i. A **PrStr** label (*) is given to the vowel midpoint of the nearest syllable to a salient F0 contour. Such salient pitch movement is not required to occur *on* the PrStr syllable.
    ii. Where possible, content (rather than function) words were favoured.
    iii. **TPs** were better over- than underspecified especially at boundaries (see 3.iii).
    iv. A maximum of 6 TPs were allowed per identified contour.
    v. **Ranges** were specified for the longest stretches within which pertinent changes in F0 height for constituent TPs would not be obscured (i.e. labelled as occupying the same **level**).
    vi. **Levels** were automatically calculated using the PoLaR plugin.

2. An additional '**High Interval'** tier was drawn up (not part of PoLaR transcription process).
    i. This was defined as the interval between the two highest TPs in a contour, ideally of the same height, and maximally one level apart.
    ii. Contours with a single high TP were labelled with short (<20 ms) high 'intervals'.

3. Further, a '**Collated Accent'** tier (not part of PoLaR transcription process) was added, which summarised contour characteristics and facilitated extraction of grouped TP sequences.
    i. This was an interval beginning maximally one TP before *,
    which had to include *.
    ii. Labels included contour position (prenuclear/nuclear), sentence mode (declarative/imperative/WH-question/YN-question), and TP levels in the format: [position]-[sentence type]-[comma separated levels]
        - e.g. PN-D-2,4,3,3 – Prenuclear declarative of 4 TPs, levels 2, 4, 3, and 3.

iii. It was important for extraction purposes that TPs were not shared across collated labels, even if in fact two contours effectively shared a boundary. Edge TPs were duplicated as needed, often only milliseconds apart. This is an exclusively clerical measure, allowing in practice for the same TP to be cited twice (e.g. once as a right edge, and once as a left edge).

4. Steps 1-3 allowed for the automatic extraction of:
   i. **PrStr (with * time)**
   ii. **TPs (with time, F0, F0 standardised by global range, and calculated level)**
   iii. **Whole contours (with position, mode, start/end times, and duration)**
   iv. **High intervals associated with each contour (with start/end times and duration)**

5. After extraction, the following measures were calculated:
   i. **PrStr to H**: Time from * to beginning of high interval
   ii. **TP timing from ***: TP timepoints as percentage of *-to-end. This allows 0 to be consistently interpreted as * when examining time-normalised contours, and scales distance between * and a preceding TP relative to the duration of the post-* contour.

A sample annotation using the above conventions is provided in Figure 93, using a sentence from modern Waterford speaker DE1's reading of *An Mac Scaiptheach*. In this example, there are two syllables marked as prosodically 'strong' by virtue of exhibiting increased intensity relative to the preceding context in conjunction with a visually salient pitch event: *roinn* 'share(d), divide(d)' and the first syllable of *eatarthu* 'between them'. The strong syllables are associated with a prenuclear and nuclear contour, respectively, each defined by five turning points. The two accents are considered to fall within a single pitch-range of 135-280 Hz.

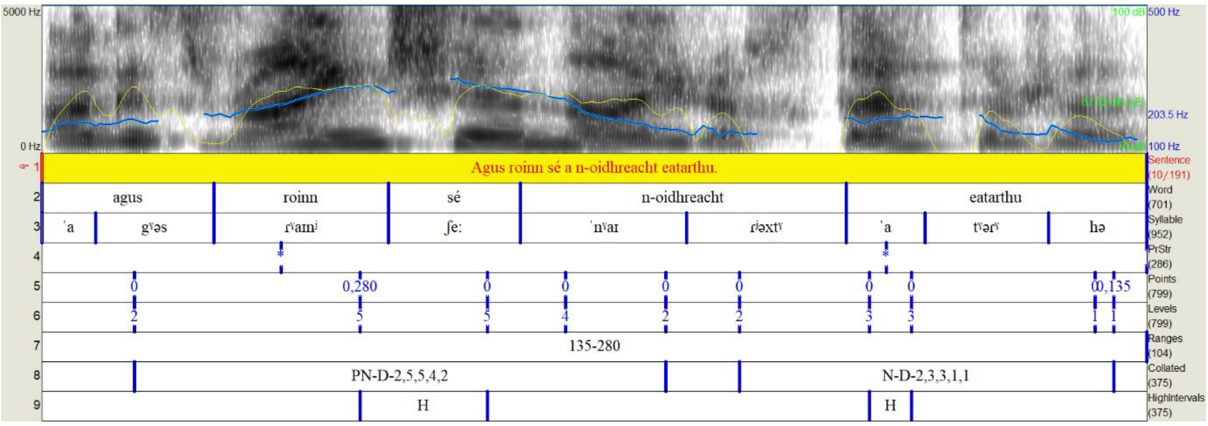

Figure 93 *Example PoLaR annotation in Praat. Core PoLaR components can be seen in Tiers 4-7, marking prosodically strong syllables (PrStr, <*>), turning points (0, with <0,#> specifying an estimated Hz value for a point if automatic pitch tracking is unreliable), local F0 range in Hertz, and levels automatically calculated by breaking the specified range into 5 parts. Phrase-positional and modal information is assembled in the 'Collated' interval tier (8). High intervals are marked on Tier 9.*

In addition to comprising the same number of turning points, each accent shows a high interval of over 50 ms between their second and third TPs. The nuclear accent has a less pronounced excursion, achieving a maximum level of 3 within the specified range, and its high region is centred on the strong syllable. The prenuclear accent has a longer high interval at level 5, which begins approximately 125 ms after the midpoint of the strong syllable and then stretches 205ms into the midpoint of the following syllable (monosyllabic pronoun *sé* 'he'). Both accents show gradual rises from the initial turning point to the beginning of their respective high intervals, and after a gradual fall to the fourth TP conclude with an extension of low pitch to the fifth and final TP.

A total of 4,782 contours were transcribed for the 1928 data, and 3,705 for the 2020-21 data, for a total of 8,487 tokens. In Section 7.2, the distribution of these nearly 8,500 contours across sentence modes and phrasal positions are presented, and categorisation of contours according to timing of their high-pitch intervals is introduced. In Sections 7.3-7.4, contour shapes and distribution of timing categories is presented for prenuclear and nuclear position.

7.2 Distribution of the data

In terms of sentence mode, the data are extremely limited. This uneven distribution can be seen clearly in Figures 94 (1928 data) and 95 (2020-21 data). The vast majority of sentences produced in both era-groups are declaratives. This is unsurprising in the context of narrative reading and recitation, but does effectively eliminate the possibility of looking at intonational differentiation of sentence modes (e.g. questions versus statements).

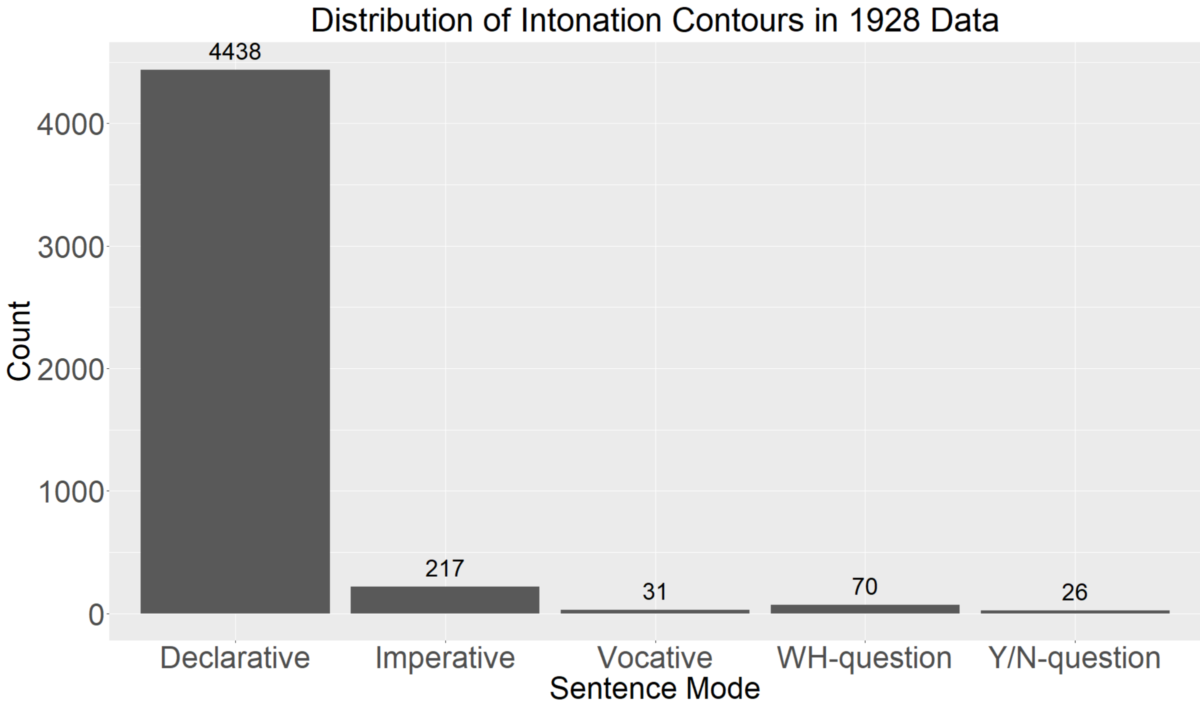

Figure 94 *Distribution of described contours across sentence modes. Declarative phrases clearly outnumber the others by a great margin.*

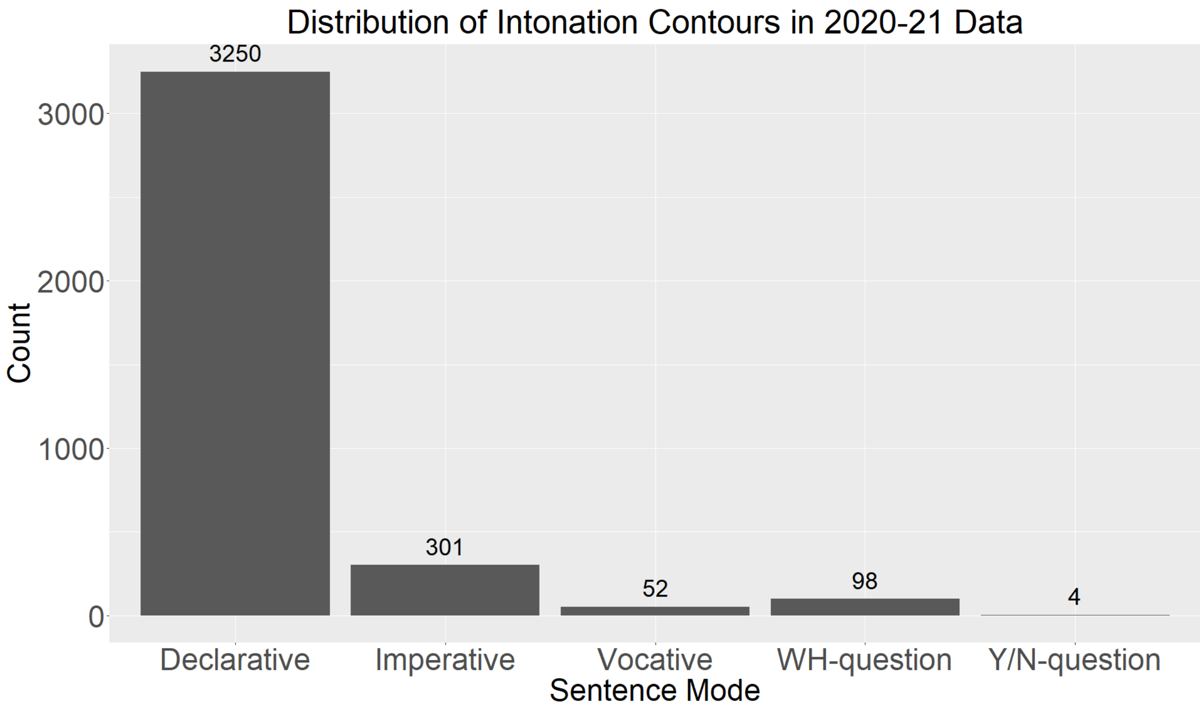

Figure 95 *Distribution of described contours across sentence modes in the 2020-21 data. Declaratives are by far the most common, as in the 1928 data.*

For both the 1928 and 2020-21 data, declarative sentences form an overwhelming majority: 93% for 1928 and 88% for 2020-21. This comes as no surprise, and is the primary reason why a description of possible pitch-accent types for Munster Irish is not the aim of this investigation. The potentially restricted range of intonational events resulting from a particular storytelling and/or reading style of speech further compounds the problem. As a consequence, while it will be possible to make descriptive observations about the contours analysed, including their temporal and scaling properties, these are not intended to be treated as more than what they are: preliminary observations of intonation in limited, and almost entirely declarative (and narrative) sentences. On the other hand, it is convenient that the distribution of sentence types and styles of delivery are in harmony between the two era-groups. Within the limits imposed by the nature of the data, this means that cross-era comparison is fairly well facilitated.

Timing of high pitch is explored systematically for prenuclear and nuclear contours in Sections 7.3 and 7.4 below. As a matter of introductory framing, however, in both the 1928 and 2020-21 data, approximately 10% of all observed accents have the beginning of their high intervals closely aligned to the prosodically strong syllable, with the calculated PrStr-to-High-Interval value within 10ms of 0. For the 1928 data, 62% of accents have measured high intervals beginning after the vowel-midpoint of the relevant strong syllable (even if only slightly in many cases). Within that subset, 36% are within 50 ms, 16% within 20 ms, and 9% within 10 ms. Of the remaining 38% of cases which have high interval onsets preceding the labelled <*>, 62% anticipate by 50ms or less, 27% by 20 ms or less, and 15% by less than 10 ms. Meanwhile, for the 2020-21 data, 42% of accents have high intervals beginning after the midpoint of the strong syllable; 48% of these have high interval onsets within 50 ms of *, 24% within 20 ms, and 9% within 10 ms. Of the 58% of accents the high interval onsets of which anticipate *, 58% do so by 50 ms or less, 22% by 20 ms or less, and 9% by 10 ms or less.

This leaves some 55% of 1928 accents and 53% of 2020-21 accents in which the achievement of high pitch is more than 50ms removed from intensity prominence (the primary diagnostic for ‘prosodic strength’ labelling under the operational guidelines presented above). Even if we restrict these to cases of delay rather than anticipation, as high pitch anticipating * in combination with a plateau of even moderate duration could well centre on *, that still leaves 42% of all 1928 accents and 29% of all 2020-21 accents with a delay of more than 50 ms. A substantial minority are even further delayed at over 100 ms (28% for 1928, 24% for 2020-21). Given average syllable durations for both eras in the neighbourhood of 200ms, and the statutory location of * at the midpoint of the syllable’s vowel, a gap of 50 (or 100 or more) milliseconds may mean that high pitch is – at least in part – located outside of the prosodically ‘strong’ syllable for analytical purposes.

In light of the above, a series of simple labels for contours based on the relative timing of the high-interval onset with respect to * were created. High intervals beginning within 10 ms of * in either direction are considered ‘on time’, those beginning 10-50 ms after * are considered ‘slightly delayed', those beginning 50-100 ms after * are considered 'moderately delayed', and those with gaps of 100 ms or more are considered 'very delayed'. Likewise for cases of apparent anticipation, 10-50 ms are considered 'slightly early', 50-100 ms 'moderately early', and 100 ms or more 'very early'. I would emphasise the rough nature of these classifications, more akin to bin-assignment for histograms than to any direct claims about phonological significance.

Having established the methods used for transcribing the 8,487 F0 contours recoverable from the 1928 and 2020-21 recordings, and for sorting them according to timing of high F0 intervals relative to the midpoint of metrically strong (intensity-prominent) syllables' vowels, we can now proceed to findings for intonation and high-pitch timing in the various region- and era-groups.

7.3 Prenuclear contours

I turn first to contours in prenuclear position. Rough contour shapes are presented in Figures 96-97, in which time-normalised TPs are plotted using their F0 values converted to semitones with reference to 50 Hz and then z-scored by participant. These allows the reader a general impression of contour shapes, but it is worth underscoring that these overall shapes are only marginally interesting with respect to the research question that guided the present investigation (RQ3). This should be borne in mind when considering the apparent disorderliness of the normalised contours as depicted.

Recall that it was decided to normalise time for each TP as a percentage of the duration between * (the vowel-midpoint of the metrically strong syllable) and the end of the described contour. The primary advantage of this normalisation strategy is that it makes explicit the location of the strong syllable, i.e. 0 on the x-axis. One alternative would be to use TPs themselves as a proxy of discrete timepoints, rather than a continuous representation of the dimension, but this greatly distorts the representation of time by disregarding scaling between TPs. For example, a 3-TP contour with 100 ms between the first and second TPs and 300 ms between the second and third would be depicted as having equal 'time' in these two intervals (i.e. equally-spaced x-axis ticks for TPs 1, 2, and 3).

Regarding depiction of TP height, F0 converted to semitones and speaker-standardised was chosen over PoLaR levels. For simultaneous visualisation of thousands of contours, as in Figure 96, the limited number of levels made the discrimination of individual patterns difficult – something which is already challenging with the standardised F0 values. While it may seem ironic to have undertaken a PoLaR intonational analysis only to set aside its definitional ranges and levels for the presentation of the transcribed contours, I would emphasise that this is largely an aesthetic matter. Range-derived levels are useful in making determinations of locally significant changes in F0 height were central to the derivation of the high-interval timing measure central to RQ3, and for approaching the description of contours' left- and right-peripheries. Note also that contours are separated according to number of constituent TPs for ease of presentation.

Evident amidst the perhaps somewhat chaotic noise of Figures 96-97 is that the vast majority of the contours described are falls or rise-falls. In general, given the style-limited nature of the data, it is not surprising to find such limited variation in contour shapes which, while not strictly homogenous, can clearly be seen to be variations on a theme with very limited exceptions. As discussed in Section 7.2, an overwhelming majority of the F0 contours described come from declarative utterances in a narrative/storytelling context. This is therefore not proposed to represent the extent of intonation in Munster Irish varieties for various sentence modes.

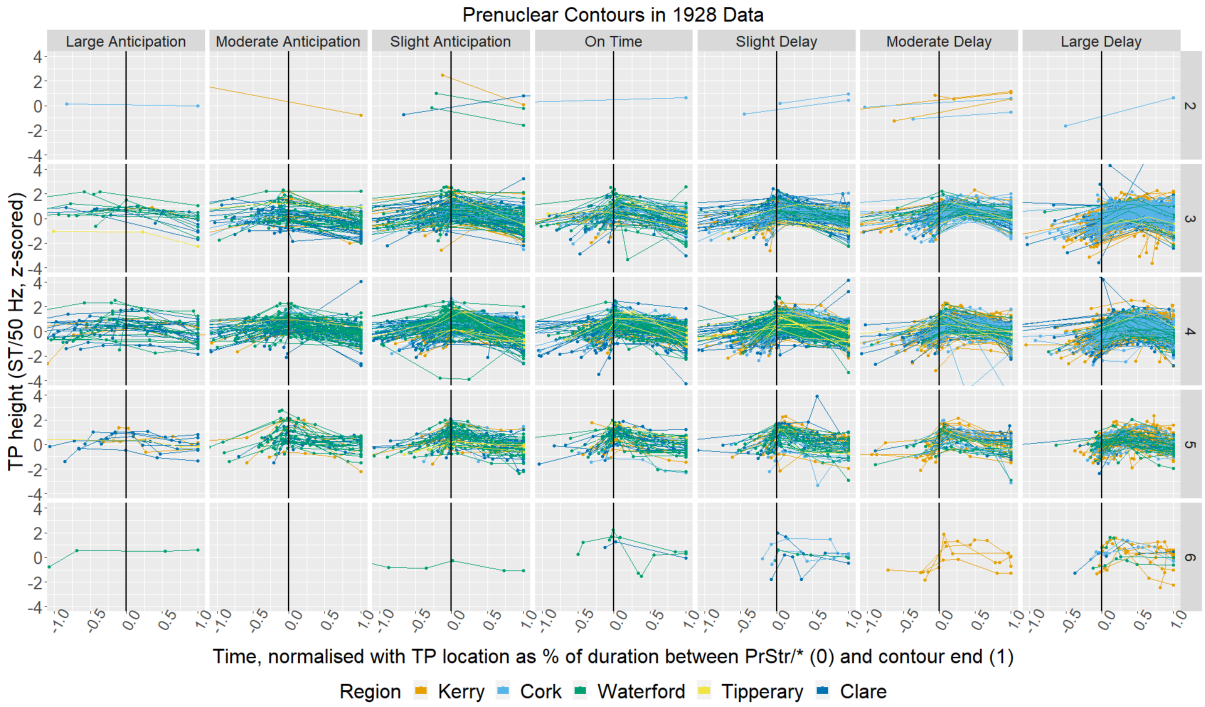

Figure 96 *Prenuclear intonation contours from the 1928 data, organised by timing category (columns) and number of TPs (rows). F0 is displayed in semitones relative to 50 Hz z-scored by participant, and time is normalised such that turning points are shown as percentages of a described contour's duration, beginning at the midpoint of the strong syllable (*).*

For the 1928 data (Figure 96), with the exception of linear falls and rises in the small number of 2-TPs, there is generally a rise between the first and second TPs, and a fall between the penultimate and final TPs with an intervening high plateau or single high TP. A very limited number of fall-rises can be seen, but on the whole both the individual contour lines and median values over time-ranges show a clear preference for rises followed by falls. There is little shape-variation appreciably linked to the various regions, with the possible exception of a greater incidence of initial high plateaux for Clare speakers (orange in Figure 96), particularly in contours of 3 and 4 TPs. By contrast, regional variation in terms of timing of high regions relative to metrically strong syllables is somewhat evident in the figure, but is better considered numerically than visually, as in Section 7.3.1 below.

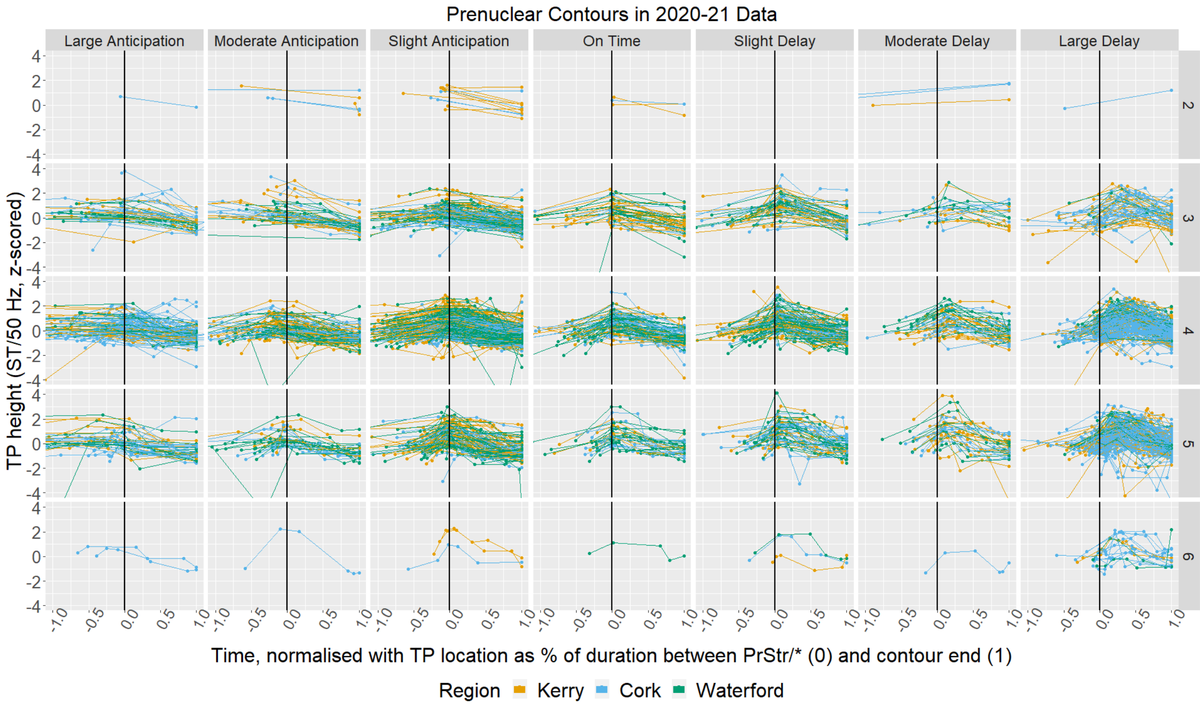

Figure 97 *Prenuclear intonation contours from the 2020-21 data, organised by timing category (columns) and number of TPs (rows). F0 is displayed in semitones relative to 50 Hz z-scored by participant, and time is normalised such that turning points are shown as percentages of a described contour's duration, beginning at the midpoint of the strong syllable (*).*

For the 2020-21 data (Figure 97), this is largely unchanged. Contour shapes in Figure 97 are consistent across the three regions, with no obvious subgroupings emerging (RQ3a). In a slight departure from the 1928 data, however, there appears to be a higher proportion of initial high plateaux in these modern data, which stretch between the first and second TPs before a final fall. This possible correspondence between an early-plateau preference in 1928 Clare and the three modern varieties calls to mind cross-era changes seen in Chapter 5 for lexical prominence, in which patterns previously characterising only Waterford/Tipperary/Clare in 1928 were seen to emerge in 2020-21 Cork and Kerry as well. This has implications for RQ3b concerning change in intonation between 1928 and 2020-21, and is returned to in discussion below.

7.3.1 Timing of prenuclear high intervals

Having established the general trend for (rise-)falls in the data, and noted the possible uptick in initial plateaux rather than rises between 1928 and 2020-21, I now move on to the matter of immediate interest for this section's research question: the timing of high intervals relative to intensity-prominent 'strong' syllables' vowel-midpoints. The distribution of contours across the seven timing categories introduced in Section 7.2 are presented for Munster subregional varieties within each era in Figures 96-97 below, beginning with the 1928 data.

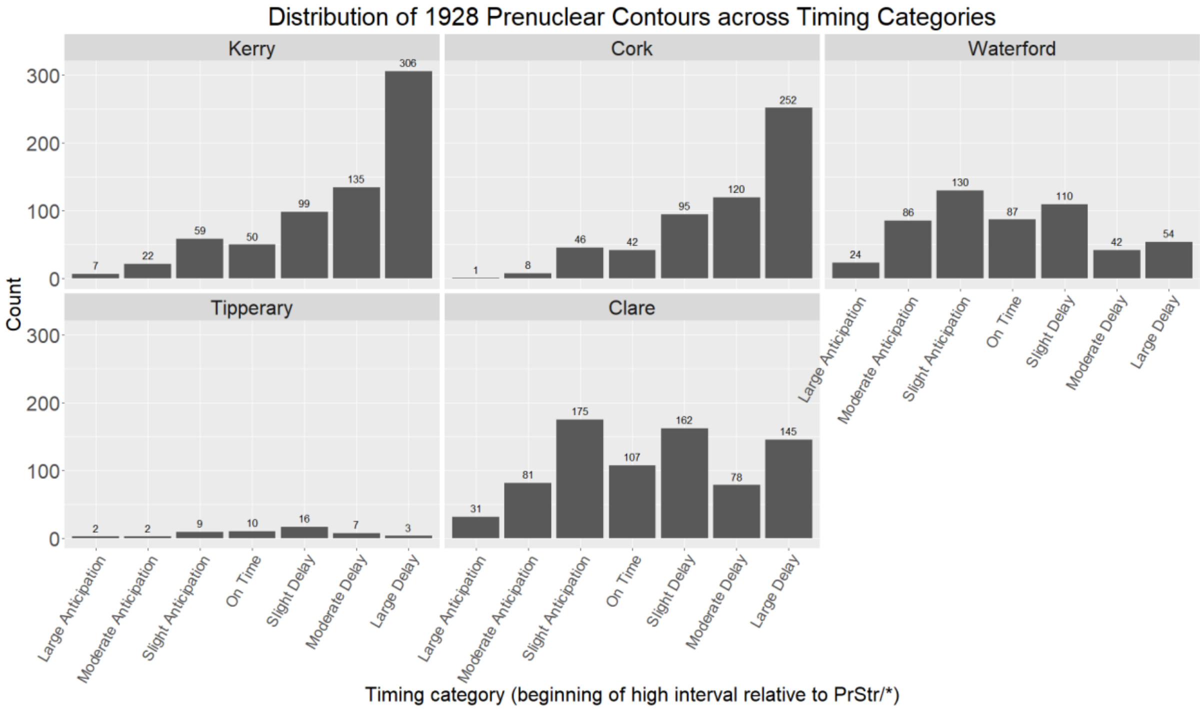

Figure 98 *Distribution of prenuclear intonation contours in the 1928 data across timing categories. The Kerry and Cork data show a preponderance of large delays (100 ms or more) between the midpoint of the strong syllable and the onset of high pitch.*

In Figure 98, 1928 Kerry and Cork speakers can be seen to pattern together with respect to timing of high intervals. Contours from these two regions show large delays between strong syllable vowel-midpoints and the onset of high F0, with timing-category frequency uniformly decreasing across smaller delays and anticipatory alignment. By contrast, Waterford, Tipperary, and Clare speakers show a preference for high-interval onsets more closely centring on the midpoint of the metrically strong, intensity-prominent syllable within a range of 50 ms (i.e. Slight Anticipation to Slight Delay). Regarding RQ3a, this highlights clear diversity in a key intonational feature across different regional varieties of Munster Irish.

The clear subdivision between regions with respect to high-interval timing in Figure 98 is consistent with that weakly evident in the contour-shapes for this era Figure 96, and strengthens the case for a non-coincidental link to the same divide in lexical prominence data for the era explored in Chapter 5. In particular, recall from Section 5.2.2 that this was evident in the distribution of F0 maxima over syllable positions in trisyllabic weight structures. In response to this, it was hypothesised that, given the relative strength of Irish as a community language in the Kerry and Cork Gaeltachtaí of the 1920s versus the greater pressure from English already present in Waterford, Tipperary, and Clare (only one of which has survived into the 21st century), the Kerry/Cork pattern is likely the more conservative. The weakened status shared by the Waterford, Tipperary, and Clare speaker communities would also be consistent with their patterning closely together despite geographic discontinuity. The continuation of this trajectory can be seen in the 2020-21 data, timing for high intervals of prenuclear contours of which are shown in Figure 99.

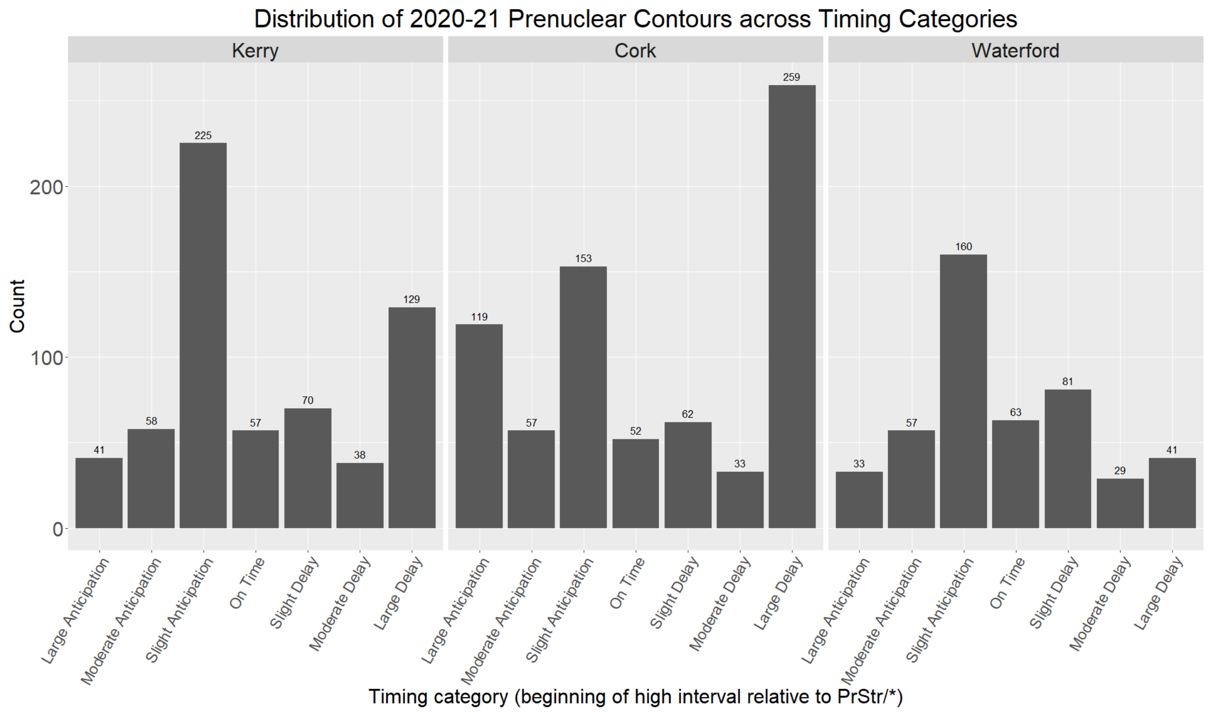

Figure 99 *Distribution of prenuclear intonation contours in the 2020-21 data across timing categories. Closer alignment with or anticipation of the strong syllable midpoint is more common for the onset of high pitch in Cork and Kerry than for the same regions in the 1928 data.*

The present-day data present rather a different picture for high-interval timing than that seen for 1928. Cork speakers still emerge as distinct in their exhibition of a large proportion of high intervals produced at a large delay (100 ms or more) from the strong syllable, while Kerry and Waterford speakers appear to favour slight anticipations. Kerry speakers' second most prevalent timing category is Large Delay, which does not have such pronounced representation in the Waterford data.

As such, the picture of high-pitch alignment for Waterford is largely unchanged from the 1928 data. While Kerry and Cork have retained a measure of the heavily rightward high-pitch alignment (Large Delay) seen in 1928, this is no longer defined by the nearly exponential increase in frequency across later timing categories as seen above in Figure 98. Instead, anticipatory – and often flat, plateaued – high pitch regions with respect to the metrically strong syllable are now the norm.

Regarding RQ3b, this shows clear change for Cork and Kerry intonation between 1928 and 2020-21. Further, with respect to RQ3a, a measure of regional heterogeneity is still present. Although alignment of high-interval onsets within 50 ms of strong-syllable vowel-midpoints is now the norm for all three remaining Munster varieties, Cork and Kerry speakers still show a sizable minority of the large (100+ ms) delays which previously comprised the majority pattern for these regions. This may indicate a recessive intonational conservatism persisting in the two varieties.

7.3.2 Shape of prenuclear contour peripheries

In addition to timing of high pitch, it is possible to sort accent-shapes into broad categories according to the relative scaling of turning points. This was done with reference to left- and right-peripheries of accents, for which the TP levels assigned in the PoLaR system proved useful. Whereas the latter were found to be of little use for visualisation of contours, for making the simple determination as to whether a given turning point is relatively higher, lower, or unchanged with respect to its neighbours, the simplified nature of the five-level system is rather helpful.

I turn first to contours' left-peripheries. Every contour in the two datasets was assigned a label according to the relationship(s) holding across up to three TPs beginning at the left edge (i.e. the beginning of the contour). This categorisation began with a question of whether the second TP was equal to, higher, or lower than the first. The same question was then applied where applicable to the change between the second and third TPs. The result is a nine-way typology, shown in Table 18.

TP1 to TP2	TP2 to TP3	Label
=	N/A	Flat
=	↘	Flat then fall
=	↗	Flat then rise
↗	=	Rise then flat
↗	↘	Rise then fall
↗	↗	3-TP rise
↘	↘	3-TP fall
↘	↗	Fall then rise
↘	=	Fall then flat

Table 18 *Nine-way typology of left-periphery shapes observed in the intonation data. PoLaR level between TPs could remain the same (=), increase (↗), or decrease (↘).*

The breakdown of left-periphery shapes for the various region groups are presented for 1928 and 2020-21 in Figures 100 and 101, respectively. For all regions and both era-groups, it is clear that the majority of described pitch accents begin with a rise between the first and second turning points. Given how few three-turning-point rises are attested, this would equate the increased second turning point with the beginning of the high interval dealt with in the plots of timing measurements.

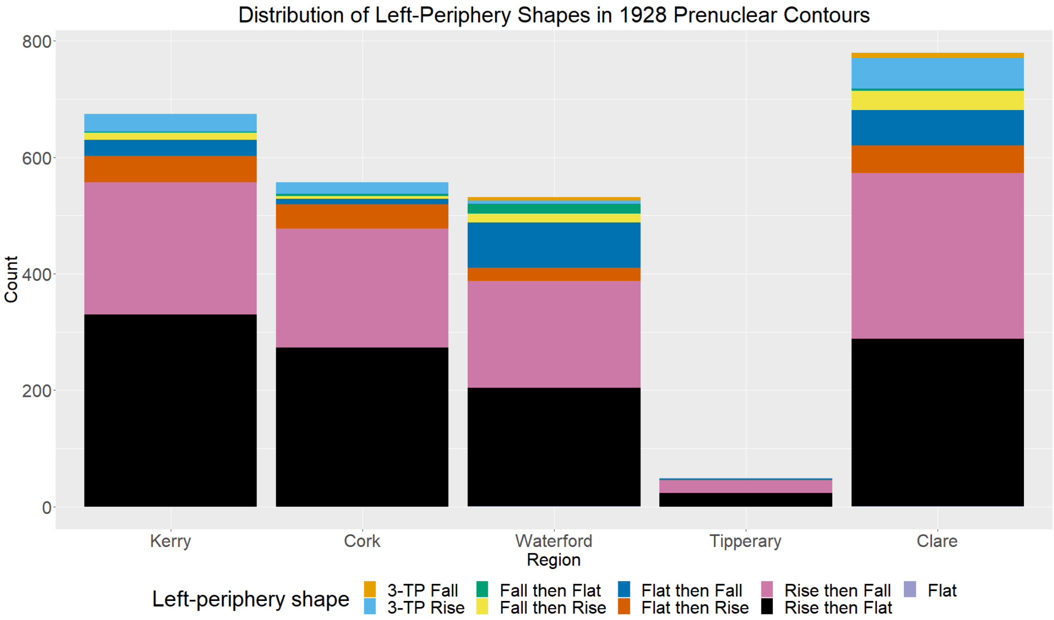

Figure 100 *Distribution of left-periphery shapes for prenuclear intonation contours in the 1928 data.*

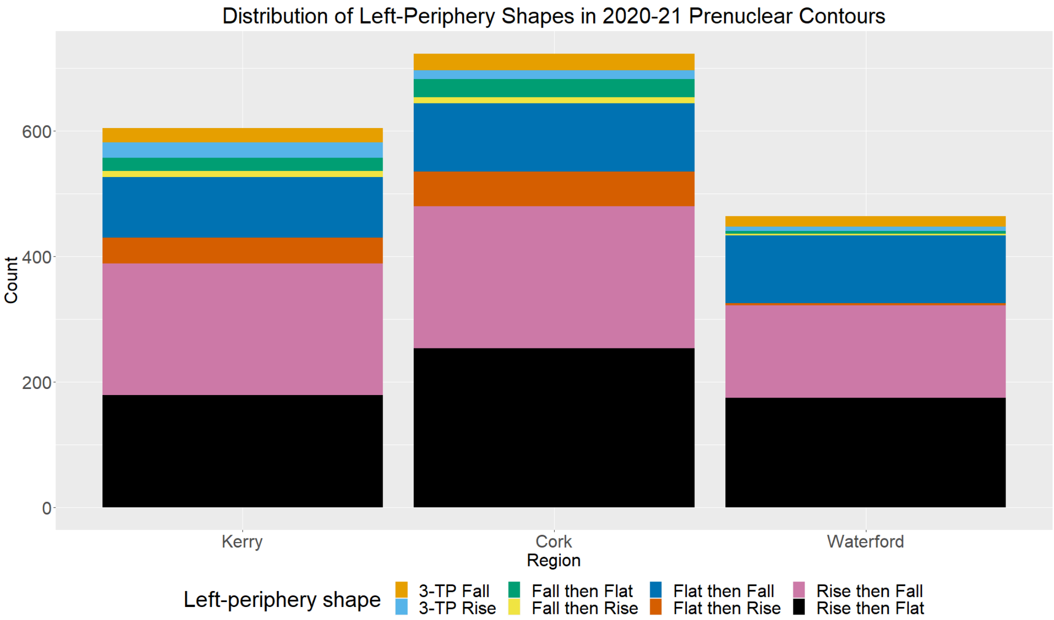

Figure 101 *Distribution of left-periphery shapes for prenuclear intonation contours in the 2020-21 data.*

For the Doegen data (Figure 100), there is some interregional variation, admittedly within a relatively small number of tokens per region (less than 400 apiece, and only 23 for Tipperary). For Clare and Waterford, flat pitch followed by a lower third turning point (flat then fall) are the third-most frequent left-periphery shape after the two initial-rise categories. For Kerry and Cork, this position is occupied by flat pitch followed by a *higher* third turning point (flat then rise). This split preference is consistent with the distribution of high-pitch timing categories seen above: the Kerry/Cork pattern matches a high interval aligned late relative to the metrically strong syllable, while the Waterford/Clare one matches an anticipatory or strong-syllable-centred high interval.

Two typical 1928 Cork/Kerry prenuclear contours (one flat-then-rise, one rise-then-flat) are illustrated in Figure 102 with 1-1-5-5-1 and 1-5-5-2 contours produced by monolingual Kerry speaker SÓC. Each falls into the Large Delay timing category, with high intervals beginning over 200 ms after the midpoint of their respective strong syllables' vowels. The first contour (the 1-1-5-5-1 flat-then-rise) also illustrates the at times tenuous nature of decision-making in identifying metrically strong syllables following the PoLaR operational guidelines outlined in Section 7.1. PrStr/* has been placed on the first syllable of *dh'éirigh* 'got up' /ˈjaɪɾʲɪ/ despite contour-local intensity actually peaking in *sé* 'he', and roughly equivalent intensity maxima in the two syllables of *dh'éirigh*.

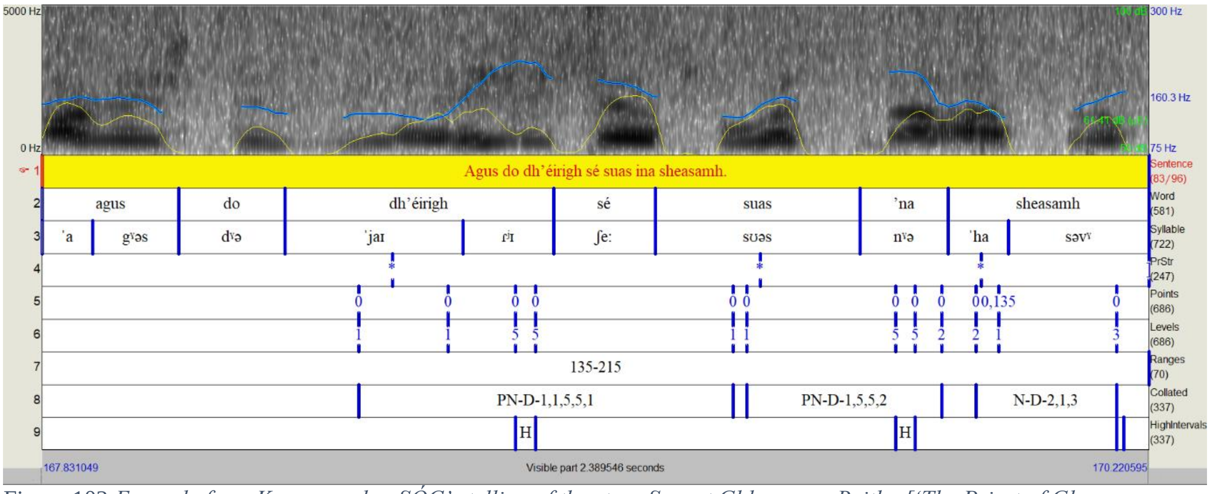

Figure 102 *Example from Kerry speaker SÓC's telling of the story Sagart Ghleann na Beithe ['The Priest of Gleann na Beithe'] showing two prenuclear rise-falls. First, a 1-1-5-5-1 prenuclear rise-fall beginning with flat, low pitch which then rises at the end of the following syllable (before falling to the end of the contour). Second, a 1-5-5-2 showing a rise-then-flat left periphery.*

The operational guidelines in use prefer * to occur on a content rather than function word, thereby disqualifying the pronoun *sé*. The choice of the first syllable of *dh'éirigh* rather than the second was made with reference to the verb's canonical heavy-light form, in which PLP uncontroversially occurs in initial position. This is not altogether satisfying in its conclusiveness, however, and should be taken as indicative of the rough, preliminary nature of the present intonational analysis.

Under the high-interval timing measure resulting from this choice of *-placement, the rise-fall in Figure 102 is considered to have a large delay (~260 ms), versus being 'on time' (~10 ms delay) if the second syllable of *dh'éirigh* with a similar case for intensity prominence were selected for *. In a sense, this very ambiguity is what is at question in interrogating the relationship between PLP and F0 and other prominence parameters. This is returned to in the chapter summary (Section 7.5) and concluding discussion in Chapter 8.

For the 2020-21 data (Figure 101), the third most frequent left-periphery shape is level pitch across the first two turning points followed by a fall. These is consistent with anticipatory high-pitch plateaux preceding and often encompassing the strong syllable, seen in Section 7.3.1 to be the preferred form of high-pitch alignment in the present-day. This is illustrated in Figure 103 using a prenuclear flat-then-fall (4-4-1-1) produced by Cork participant CO4.

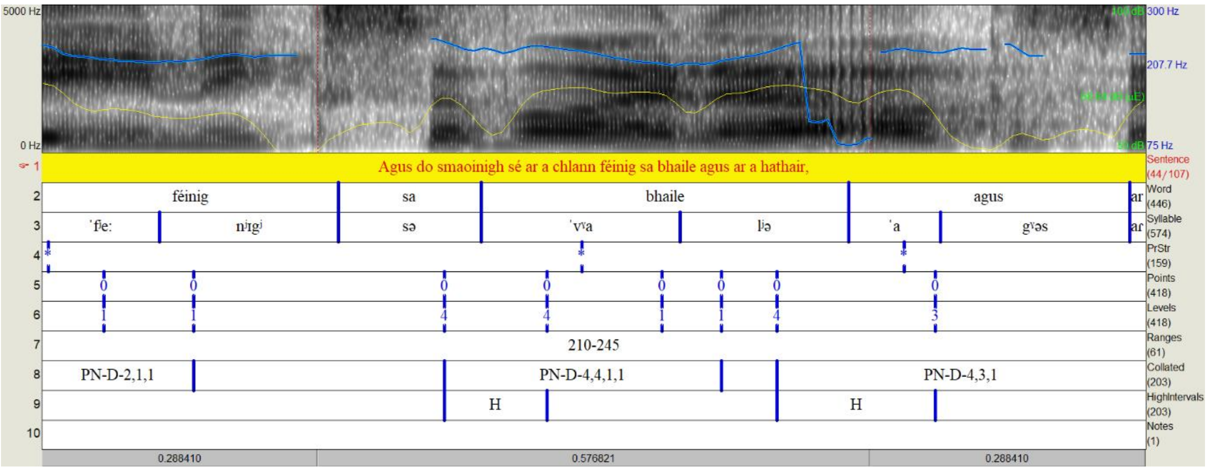

Figure 103 Example from Cork speaker CO4's retelling of the story An Mac Scaiptheach *['The Prodigal Son']: a 4-4-1-1 prenuclear fall, beginning with a high plateau which slightly anticipates the midpoint of the strong syllable (the first syllable of* bhaile *'home'), which then falls through the strong syllable.*

Turning then to right-peripheries, contour end-types were first sorted into those with final flats (i.e. the same level between the penultimate and final TPs) or falls, and those with final rises. The latter were then classified using a simple ternary system, based on whether their final turning point was higher than the penultimate one, and if so whether the penultimate turning point is higher or lower than the antepenultimate one (laid out in Table 19).

Antepenult. TP to Penult. TP	Penult. TP to Final TP	Label
=	↗	Flat then rise
↘	↗	Dip then rise
↗	↗	3-TP rise

Table 19 *Three-way typology of rising right-periphery shapes observed in the intonation data. PoLaR level between TPs in this subset of prenuclear contours could remain the same (=), increase (↗), or decrease (↘).*

This limited examination was chosen over a more exhaustive nine-way typology parallel to that for left-peripheries largely because contours in which the final turning point is higher than the one preceding it are extremely scarce for both eras. This is not at all surprising in prenuclear position; runs of the obviously predominant (rising-)falling contours were generally delineated with pre-high rises included as the first turning point of a contour, rather than the final turning point of the preceding one. Cases of rising right edges in prenuclear contours were best represented in 1928 Clare speakers, for whom they comprise a scant 8% of all prenuclear accents; all other regions in both eras fall below this amount. This minority, such as they are, are of more interest in prenuclear position than sustained final falls or falls-then-flat, which are uninformative with respect to high-interval timing.

Given the great preponderance of falling prenuclear contours seen previously in Figures 96-97, the minority category which is of the most interest is sustained increases in pitch level over the course of an accent's final three turning points (3-TP rises). These are most readily linked to fall-rise contours, a small number of which are visible in the plotted contours in Figures 95-96, and are the point of greatest relevance for right-periphery shape with regard to high-pitch timing. For the final half (minimally) of a maximally 6-TP contour with up to one TP preceding the midpoint of the metrically strong syllable, the most fall-like form that could co-occur with successive increases in F0 across the final three TPs would be something ambiguously V-shaped.

Within the meagre representation of apparently rising contours in prenuclear position, we can look at the relative breakdown of these contours' right peripheries in Figures 104-105. Distribution of tokens across the three categories appears to vary between regions and era-groups, but given the low token-count the meaningfulness of this should be treated with caution.

In the 1928 data (Figure 104), sustained rises across three turning points leading to the right edge of the contour are best attested in the Clare data, in which they comprise 40% of the 63 available tokens. For the remaining regions, in descending order, these 3-TP rises comprise 28%, 22%, 7%, and 0% of all high-ending prenuclear contours for Cork, Kerry, Waterford, and Tipperary. The remaining high-ending termini subcategories, flat-then-rise and dip-then rise, are variably distributed by region. Kerry, Clare, and Waterford speakers show slightly more dips (44% for Kerry, 42% for Clare, and 72% for Waterford) than pre-final flat troughs (33%, 17%, and 21%). Additionally, the only prenuclear observation from Tipperary with a final rise is a one-turning-point dip. This leaves Cork alone in its apparent preference for troughs over dips, at 46% and 26%, respectively.

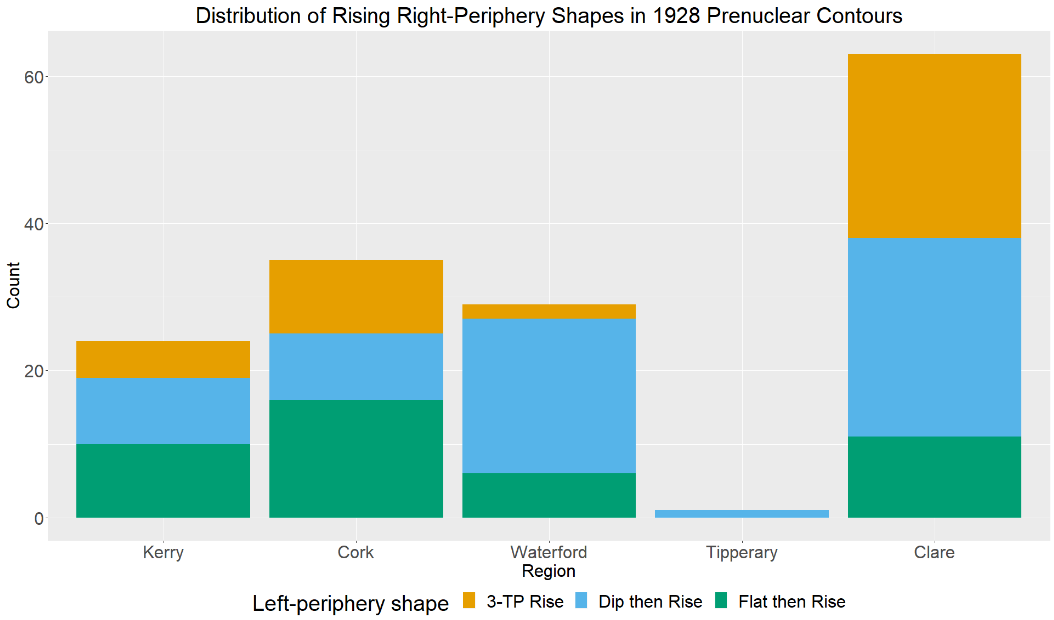

Figure 104 *Distribution of right-periphery shapes with final turning points higher than the penultimate for prenuclear intonation contours in the 1928 data.*

Cases of prenuclear accents with rising right peripheries are even rarer in the modern data, with fewer than 35 tokens for each of the three regions. Distribution of these limited observations across the three final-rise subcategories is shown in Figure 105. Broadly speaking, single-point dips are the most common subtype at 71% for Kerry, 56% for Cork, and 82% of Waterford (with <20 observations). For Cork and Waterford, the remainder entirely comprise two-point troughs (flat-then-rise). For Kerry, three cases of sustained rises (8% of rising-end prenuclear contours) are attested, with two-point troughs making up the remaining 21%.

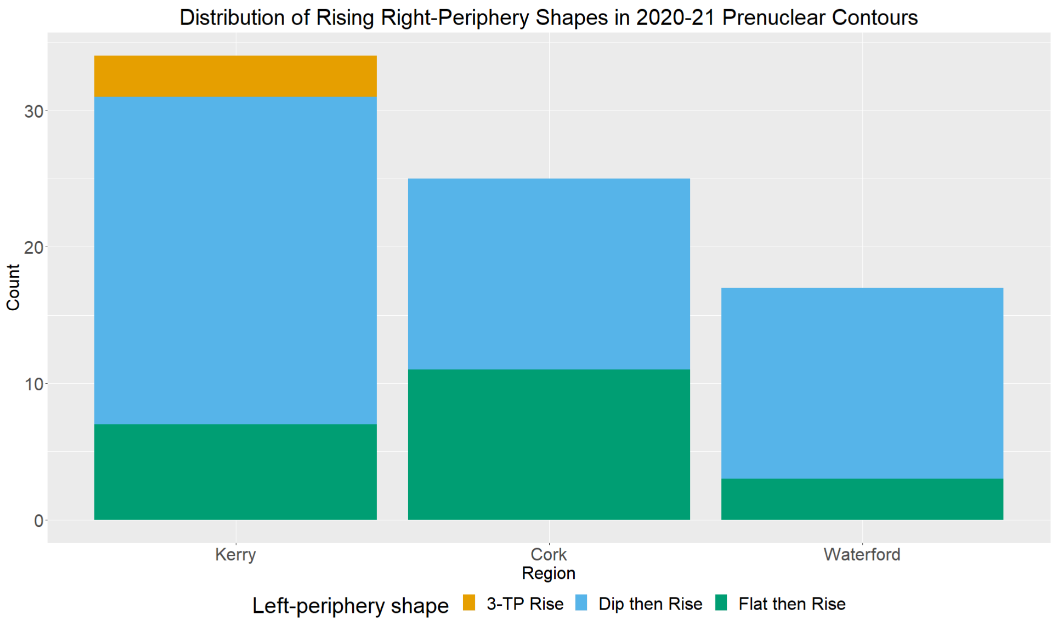

Figure 105 *Distribution of right-periphery shapes with final turning points higher than the penultimate for prenuclear intonation contours in the 2020-21 data.*

7.3.3 Summary of prenuclear contours

This section summarises the above treatment of prenuclear contours in the available intonation data. An initial plotting of the transcribed prenuclear contours in the introduction of this section showed an overwhelming majority of rise-falls and falls for both eras, with a marginal increase in falls preceded by initial high plateaux for the modern (2020-21) data.

The most striking finding was with regards to RQ3, i.e. the question of how high pitch aligns with metrically strong syllables in Munster Irish varieties. In Section 7.3.2, it was clear that 1928 speakers from Cork and Kerry (previously identified to be more conservative in this era than the other three regions for which data are available) strongly preferred to align high-pitch regions of prenuclear intonation contours such that they began minimally 100 milliseconds after the midpoint of the local 'strong' syllable's vowel – classified as a Large Delay in the seven-category timing system devised. This contrasts with the closer alignment (generally within 50 ms) between high pitch and metrical strength for 1928 Waterford, Tipperary, and Clare – regions which were also seen in Chapter 5 to show closer coordination between intensity- and pitch-prominence patterns at the lexical level.

In the modern data, while the Waterford pattern has remained largely unchanged, Cork and Kerry speakers show heavily altered high-pitch alignment. Both regions retain a substantial minority of large delays (more strongly in Cork), but these are now outnumbered cumulatively by cases ranging from delays of 50 ms or less to large anticipations (i.e. high pitch beginning 100 ms or more *before* the midpoint of the strong-syllable vowel). Regarding RQs 3a-b, there is evidently variation in temporal alignment of high pitch across regions in both eras (RQ3a), and there is further evidence of dramatic change between 1928 and the present day for Cork and Kerry (RQ3b).

Finally, with respect to the shape of contours' left and right peripheries, there is a well-evidenced preference for initial rises either to sharp peaks or to plateaux defined by two turning points of equal level. For right peripheries, increased pitch level between penultimate and final TPs is evidently unusual in prenuclear position. Within the limited instances of this occurring, roughly 20% of 1928 cases (36 tokens out of 172) represent three- and four-point contours with two low-level points followed by a rise – something approximating an overall rise, or at the very least lacking a realised fall in pitch after the strong syllable. This is not the case for the modern data, in which the majority of the very limited cases of the flat-then-rise case comprise 5-6 turning points, allowing more space for a preceding high region, with the observed final rise more likely connected to the transition into an adjacent falling accent.

7.4 Nuclear contours

As for prenuclear accents, rising-falling contours are once again dominant in nuclear position for all region groups and eras, as evident in Figures 106-107.

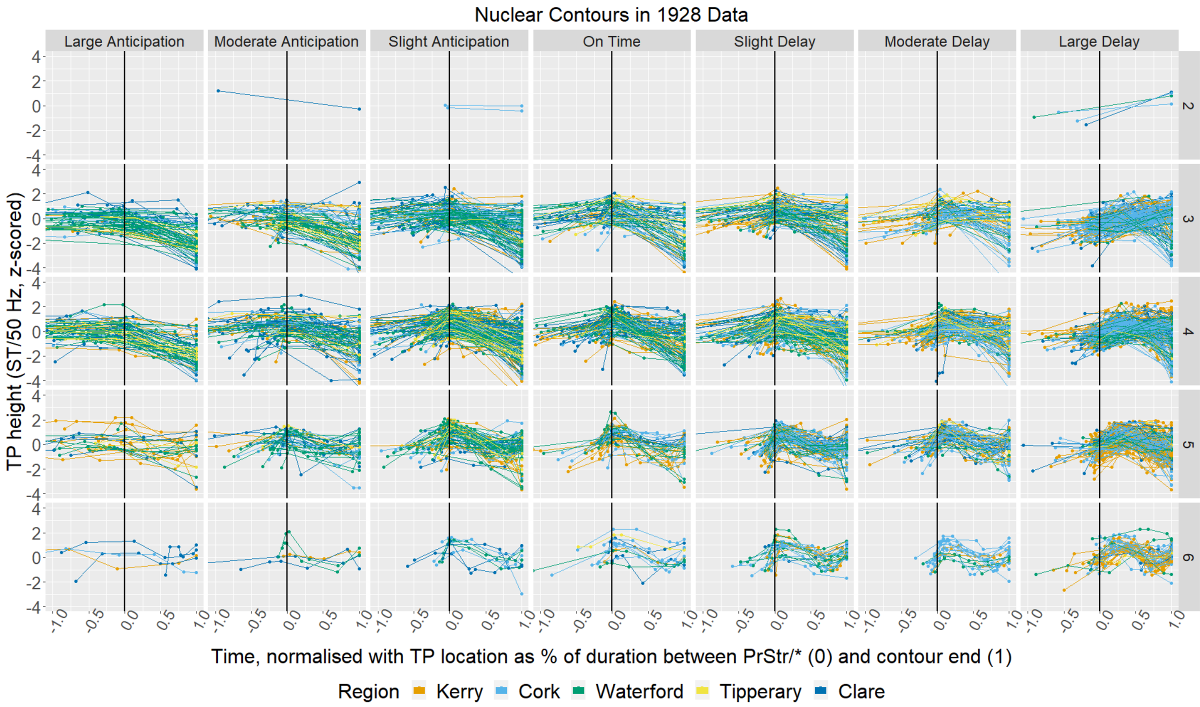

Figure 106 *Nuclear intonation contours from the 1928 data by timing (column) and TP-count (rows). F0 is in speaker-standardised semitones, and time is normalised with respect to the midpoint of the metrically strong syllable's vowel.*

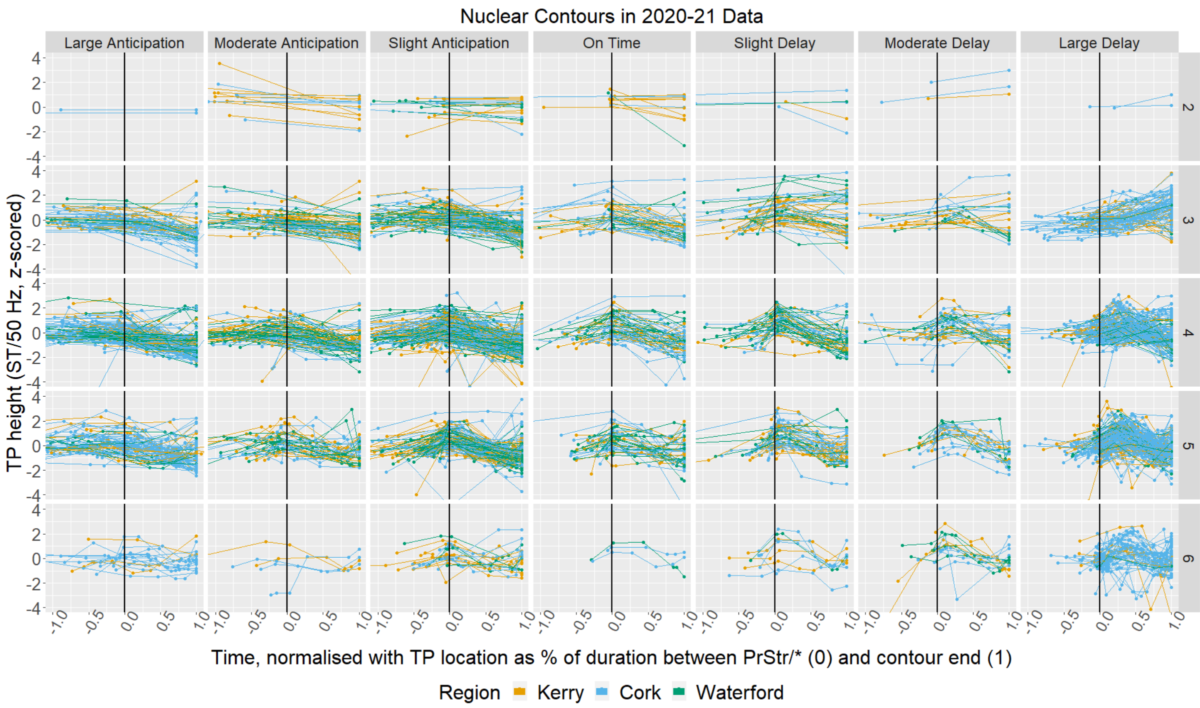

Figure 107 *Nuclear intonation contours from the 2020-21 data by timing (column) and TP-count (rows). F0 is in speaker-standardised semitones, and time is normalised with respect to the midpoint of the metrically strong syllable's vowel.*

7.4.1 Timing of nuclear high intervals

Distribution of high-interval timing categories, shown in Figures 108-109 below, emerges as roughly equivalent to that found in prenuclear position for all regions and era-groups, suggesting that this particular feature is not dependent on position, at least not heavily. With that said, there is a greater proportion of on-time or only slightly delayed high intervals for 1928 Kerry and Cork than was to be seen in the prenuclear data, perhaps reflecting contextual variables such as the amount of material following the final/nuclear metrically strong syllable.

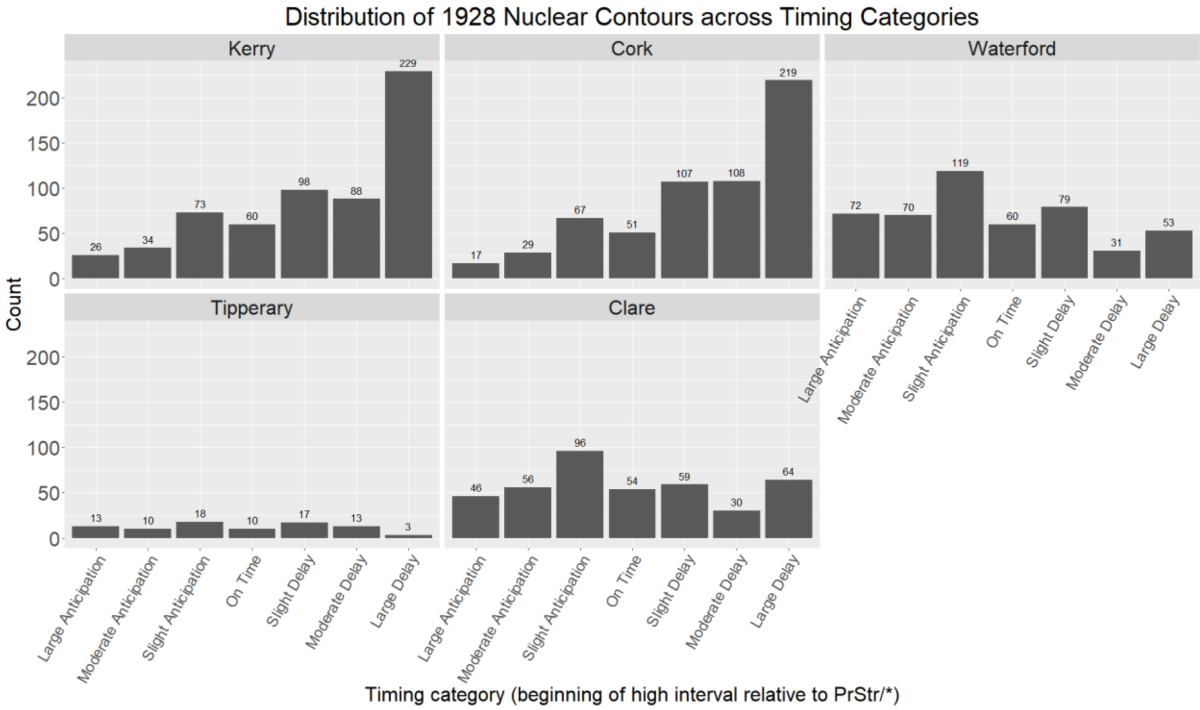

Figure 108 *Distribution of nuclear intonation contours in the 1928 data across timing categories. The Kerry and Cork data show a preponderance of large delays (100 ms or more) between the midpoint of the strong syllable and the onset of high pitch.*

For the modern data (Figure 109), there is very little appreciable contrast with the distribution of timing categories observed in prenuclear position. Kerry and Cork speakers show the same era-shift from predominant late alignment of high pitch onsets to majority on-time and anticipatory alignment, with a sizable minority of late aligned items persisting for Cork and, to a lesser extent, for Kerry. The three Waterford participants' timing measures closely resemble those of their 1928 counterparts.

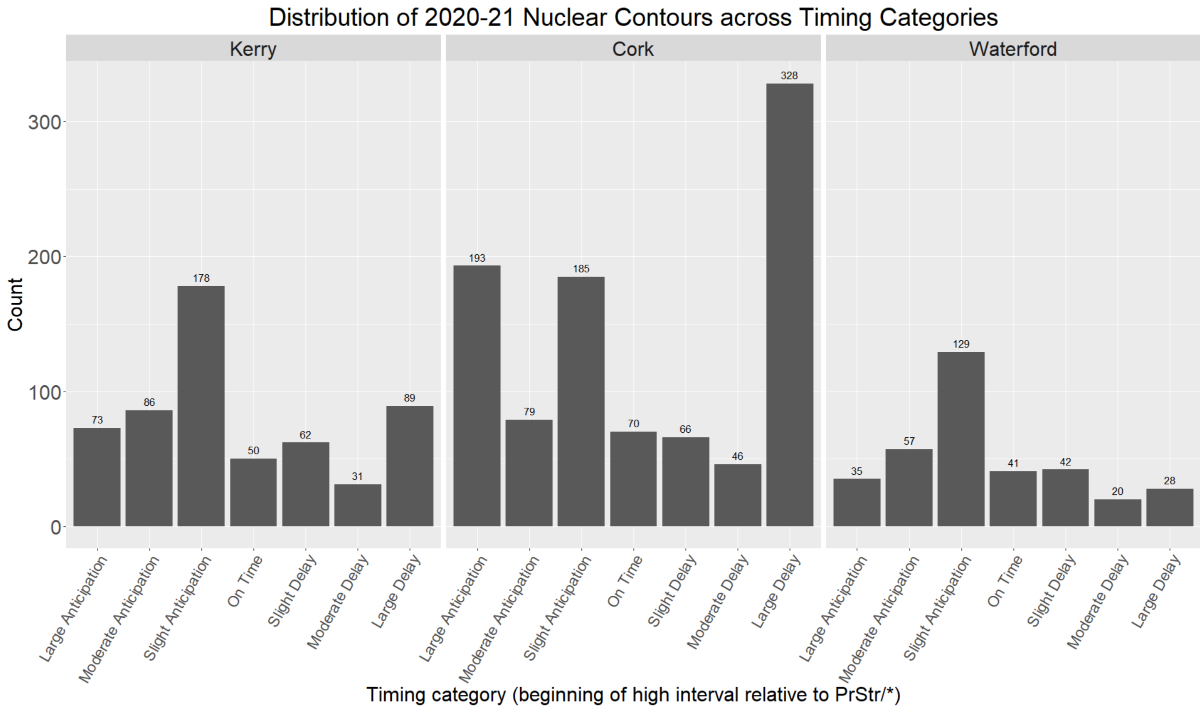

Figure 109 *Distribution of prenuclear intonation contours in the 2020-21 data across timing categories. Closer alignment with or anticipation of the strong syllable midpoint is more common for the onset of high pitch in Cork and Kerry than for the same regions in the 2020-21 data.*

7.4.2 Shape of nuclear contour peripheries

As for prenuclear accents, it is useful to consider point-based left-periphery shapes as a supplement to the explicitly time-based measure of high-pitch timing. This is done in Figures 110-111 with reference to the same nine-way typology of left-periphery shapes used in Section 7.3.2.

More variation between era-groups is evident in the left peripheries of nuclear accents than was seen to be the case for prenuclear ones. For the 1928 data in Figure 110, there is a clear predominance of initial rises to either single-point peaks or else to two-point plateaux, as for prenuclear accents. In the modern data, however, this proportion falls to 55-60%. This still leaves initial rises as the most frequent left-edge type for modern speakers’ nuclear accents, but mixed with a far more substantial minority of cases of level pitch between the initial two turning points. The latter favour high plateaux followed by falls to lower third turning points (2-TP flat then fall).

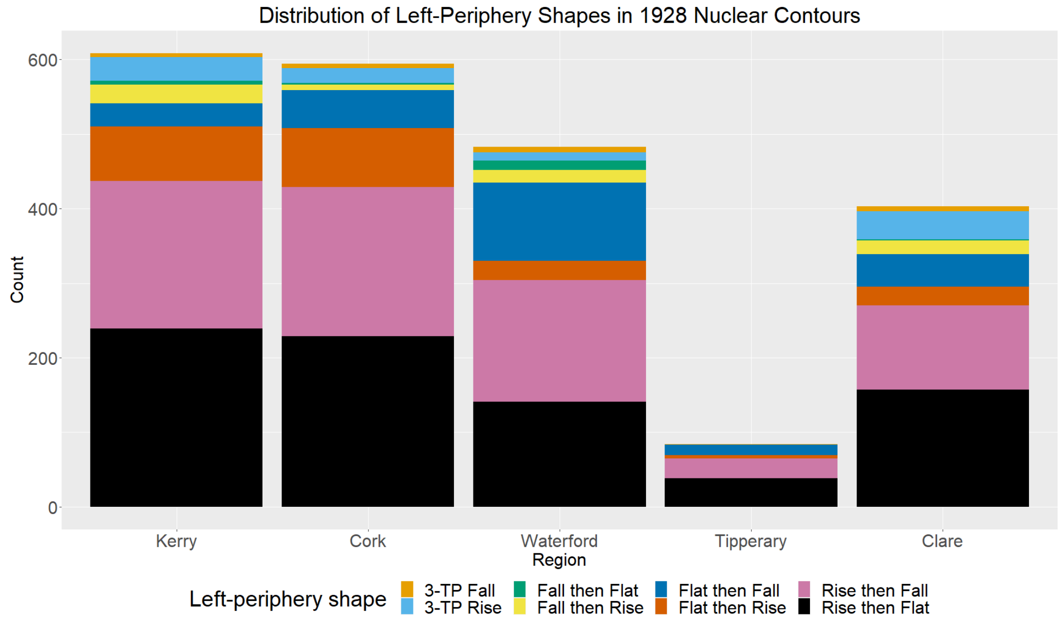

Figure 110 *Distribution of left-periphery shapes for nuclear intonation contours in the 1928 data.*

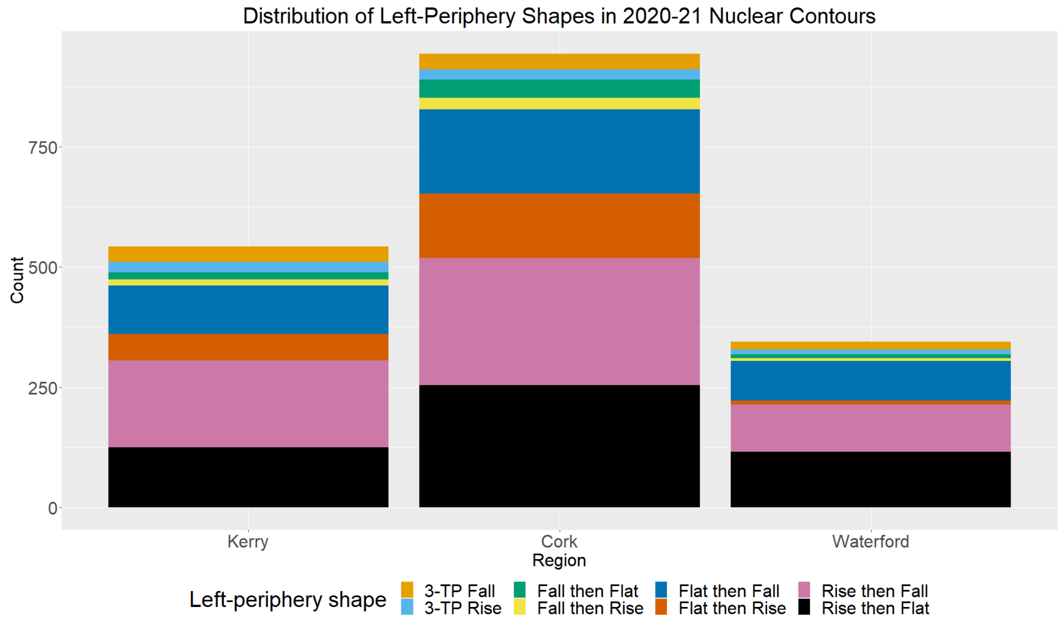

Figure 111 *Distribution of left-periphery shapes for nuclear intonation contours in the 2020-21 data.*

The modern distribution in Figure 111 aligns with initial plateaux-to-falls as the next preference after initial rise-falls in the 1928 Waterford, Clare, and (limited) Tipperary data. This is consistent with modern speakers' broad alignment with these particular subregions in last century's archival data. In other words, when not producing some form of initial rise, modern speakers from all three surviving Munster subvarieties produce more cases of anticipatory high plateaux than late-aligned rise-falls. This can be integrated with the high-pitch timing information outlined above in which anticipatory high-interval onsets outnumber all other timing categories for modern speakers, and likewise for 1928 speakers from Waterford, Tipperary, and Clare. It is only for 1928 speakers from Kerry and Cork that level pitch across the first two turning points is more frequently the lead-in to a later rise than a high plateaux before a decrease in pitch. Such gradual rises to either peaks or plateaux comprise 65% of all nuclear cases of large delay in high-interval onset-timing for the 1928 Kerry and Cork data, and 55% for the present-day Cork data (in which large delays have persisted as a sizable minority).

Next, I consider distribution of rising right peripheries for nuclear contours, using the same ternary classification system introduced in Section 7.3.2. Definitionally, nuclear accents fall in absolute final position in a demarcated intonational phrase; this lack of connection to a following contour makes nuclear right-peripheries of far more interest than prenuclear ones.

For the 1928 data (Figure 112), 586 out of 2398 total nuclear accents (approximately 25%) have final turning points at a higher range-local level than the preceding one. Of these, roughly half (291) have a penultimate dip in pitch-level – i.e. a V-shaped fall-rise – while only ~10% (57) have contiguous rises from antepenultimate turning point to penultimate to final. The remaining ~40%, by elimination, represent a lower pitch-level sustained over two or more pre-final turning points, followed by a final rise. In terms of regional breakdown, only for Tipperary do rise-ending nuclear contours account for less than 23% of cases, at only 5%. However, this is likely due to the extremely limited amount of data available for this region (only 84 nuclear accents). The majority rate of incidence is notably higher than for prenuclear accents, in which for all regions – not just the scantly attested Tipperary – final pitch-increases represented 8% or less of accents.

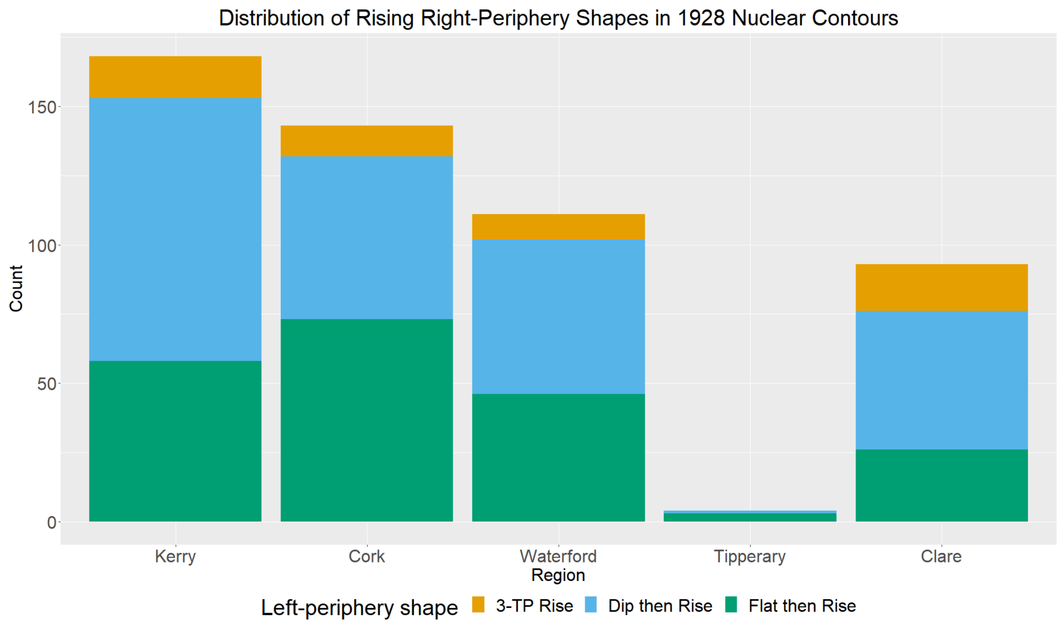

Figure 112 *Distribution of right-periphery shapes with final turning points higher than the penultimate for prenuclear intonation contours in the 1928 data.*

There is no obvious subregional patterning in distribution of different end-types for the contours described, in terms of neither falling/neutral versus rising termini, nor of subtypes within the latter terminal rises. Within the attested high-ending contours, extended (3-TP) rises are clearly in the minority, comprising only 8-9% of high-ended contours for Kerry, Cork, and Waterford, 18% for Clare, and not appearing at all in the limited Tipperary data. Final rises preceded by two lower turning points (flat-then-rise) in turn comprise 37% for Kerry, 50% for Cork, 28% for Clare, 41% for Waterford, and 75% (i.e. 3 of 4 tokens) for Tipperary. An example of this is provided in Figure 113, which shows a 3-5-4-4-5 nuclear contour produced by Kerry speaker AÓG. The remaining contours for each region are then final highs preceded by a single-TP dip in level (dip-then-rise), as illustrated in Figure 114 with a 3-3-5-5-1-2 contour produced by Kerry speaker SÓC.

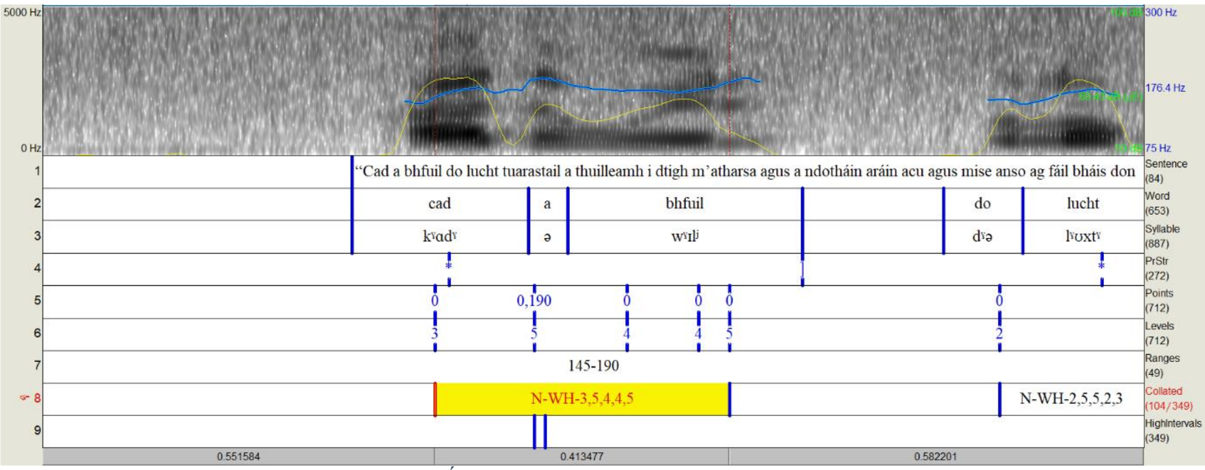

Figure 113 *An example from Kerry speaker AÓG’s retelling of An Mac Scaiptheach, showing a five-point nuclear accent ending with a flat stretch of lower pitch (level 4) followed by an upturn to level 5 on the final turning point.*

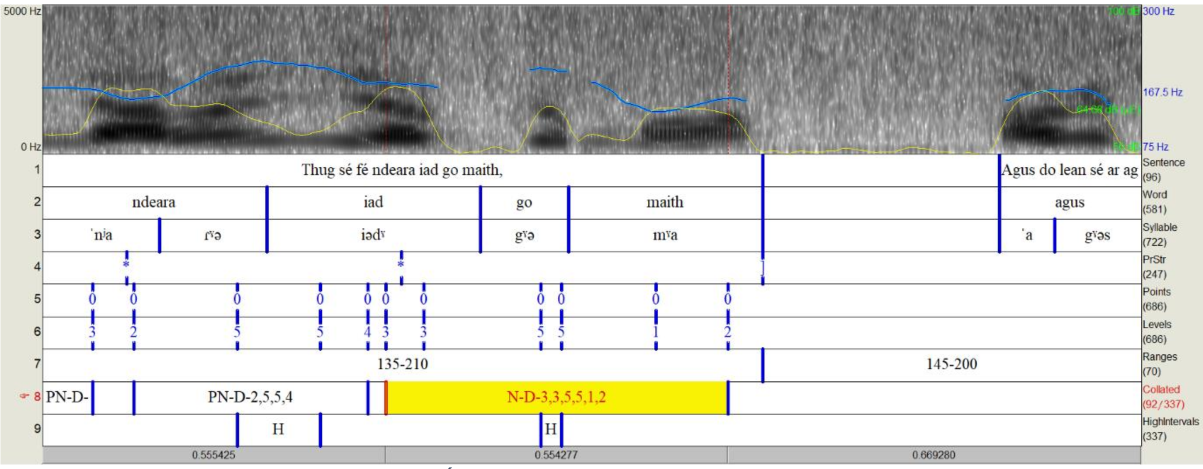

Figure 114 *An example from Kerry speaker SÓC’s telling of* Sagart Ghleann na Beithe *(‘The Priest of Gleann na Beithe’), showing a six-point nuclear 3-3-5-5-1-2 contour ending with a sharply defined, single-point dip in pitch level followed by a rise to the final TP.*

For the modern data, shown in Figure 115, the picture is slightly different, particularly for Kerry and Waterford. 24% of all nuclear accents in the modern Cork data conclude with rising termini, an equivalent proportion to that seen for the same region in 1928 (along with contemporary Kerry, Clare, and Waterford). In the modern Kerry and Waterford data, however high rising termini account for only 16% and 10% of nuclear cases, respectively.

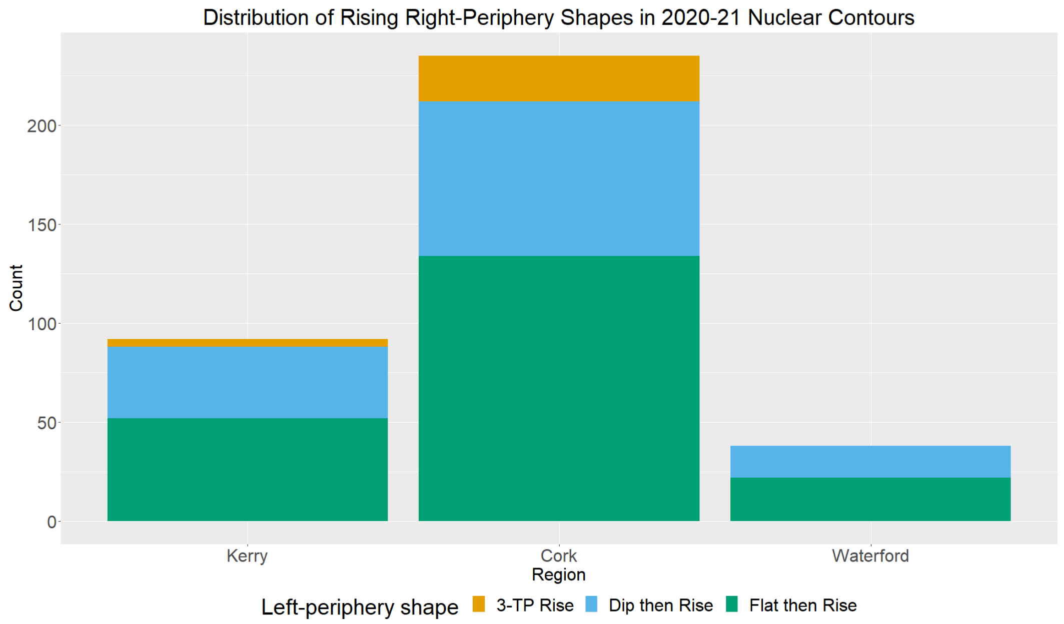

Figure 115 *Distribution of right-periphery shapes with final turning points higher than the penultimate for prenuclear intonation contours in the 2020-21 data.*

Turning then to the breakdown of high-terminus subtypes, things do not look greatly different to in the 1928 data. Continuous rises over a minimum of three turning points once again comprise a very slim minority of cases at only 4% of Kerry nuclear accents, 10% for Cork, and none at all for Waterford. Cases of two low turning points before a final rise comprise 56-58% of cases for each of the three regions. The remaining cases of single-turning-point dips in pitch level before a final rise represent 39%, 33%, and 42%, for Kerry, Cork, and Waterford, respectively.

7.4.3 Summary of nuclear contours

To summarise, in the context of the stylistically limited, overwhelmingly declarative intonation data available from 1928 and 2020-21, rise-falls once again comprise the majority of intonation contours, as in prenuclear position. In terms of high-pitch timing relative to metrically strong syllables, the picture for nuclear contours is similar but not identical to that for prenuclear ones. Specifically, 1928 Cork and Kerry speakers were seen in Section 7.4.1 to favour large delays between strong-syllable vowel midpoints and the onset of high F0, but this was slightly more tempered than for prenuclear position, with a higher proportion of tokens in earlier-aligned timing categories. Beyond this, distribution of tokens across timing categories was virtually identical across regions and eras, including the change in Cork and Kerry from their distinctive distribution in 1928 to relatively close alignment between high pitch and metrical strength as the majority pattern. As concerns RQ3, this shows evidence of a conservative historical tendency for high pitch to occur on the syllable following metrical strength, alongside regional variation (RQ3a) and change in preferences between 1928 and 2020-21 (RQ3b).

With regards to contour periphery shapes (Section 7.4.2), final rises relative to the preceding body of a nuclear contour represent a minority of cases. Amongst such cases, three broad categories can be distinguished: (i) rises preceded by a sharp, single-turning-point dip in pitch level (dip-then-rise), (ii) rises preceded by a longer pitch trough defined by two bookend turning points (flat-then-rise), and (iii) an ongoing rise in pitch level across the three final turning points (3-TP rise). The first two are easily reconciled with the overwhelming representation of rising-falling accents defined by a clear high point or region of high pitch and a subsequent decline as phrase-final upturns in pitch following the main body of the contour.

The third rising end-type, the 3-TP rise, is in the first instance very sparsely attested in comparison to the other two. For contours which themselves are defined by only three TPs (which comprise some 61% of such sustained rises in the Doegen data and 33% in the present-day data) this indicates a sustained rise from start to finish, but not a linear one. The latter would by necessity have been transcribed as comprising only two turning points. Under an AM approach, this could be reconciled with L*+H or perhaps a low L* followed by an independent high boundary H%, but as emphasised throughout this chapter such labelling is orthogonal to the present work. For the remaining turning-point counts, a variety of contour-shapes preceding the final double-rise are attested, including rise-falls and stepwise increases in F0 via an interim plateau.

7.5 Chapter summary

Despite the initial appearance of invariant falls in the intonation data available from 1928 and 2020-21 storytelling data, and the explicitly simple, descriptive approach taken to the exploration of the same, a number of interesting points have emerged for Munster Irish intonation. These findings complement the more robust analyses of lexical-level prominence undertaken in Chapters 5 and 6, and are intended to lay the foundations for more sophisticated future study of intonation and temporal alignment in Munster Irish.

Transcription of the intonational contours available in the data was carried out using the Points, Levels & Ranges (PoLaR) system of Ahn *et al*. (2021), the operationalisation of which for present purposes was laid out in Section 7.1. This method was specifically chosen in order to focus on overall contour shapes in a phonetic sense – based on turning points in F0 – without being forced to prematurely identify such shapes with Autosegmental-Metrical labels that assume PLP location. On the basis of findings for lexical prominence in Chapters 5 and 6, metrically strong syllables were identified for the PoLaR analysis on the basis of intensity prominence. Once contours were assigned TPs, F0 ranges, and automatically-calculated levels, high-pitch intervals were demarcated in Praat in order to allow for the measurement of the distance between the metrically strong syllable's vowel midpoint and the onset of high pitch for each contour.

Contours were then assigned to seven categories on the basis of the latter timing relationship. 'On time' indicated a high-pitch interval beginning within 10 ms in other direction of the metrically strong syllable's vowel midpoint, and departures from this were classified as 'slight' (10-50 ms), 'moderate' (50-100 ms), and 'large' (100+ ms) delays or anticipations.

F0 contours in prenuclear and nuclear position were then considered in turn in Sections 7.3 and 7.4. Rough contour shapes were first presented in plots which showed speaker-standardised F0 value of TPs over time, which was normalised with respect to the distance between the metrically strong syllable's vowel midpoint and the end of the contour. For both prenuclear and nuclear contours, (rise-)falls were by far the predominant shape, although this relative homogeneity is not taken to be necessarily representative of the region's intonational inventories, given the stylistically limited nature of the data.

Turning then to the main feature of interest for this investigation – the timing of pitch accent's high peaks or intervals with respect to the local 'strong' syllable (RQ3) – the distribution of contours across timing categories was also equivalent between positions. The 1928 data exhibit a split between a large-delay preference for Cork and Kerry, and one ranging between slight anticipation and slight delay for Waterford, Clare, and Tipperary. The modern data look more like the latter pattern, with the exception of markedly high frequency of large delays in Cork and (to a lesser extent) Kerry, albeit outnumbered by overall cases of anticipation and 'on time' coordination. Prenuclear and nuclear timing results are summarised in Tables 20-23 below.

For prenuclear accents (Tables 20-21), there has been an apparent increase in Cork and Kerry between 1928 and the present day in the production of high intervals which begin in anticipation of the strong-syllable vowel midpoint. As seen in treatment of periphery shapes in Section 7.3.3, prenuclear falls of all timing categories are most often preceded by a rise, more often to a plateau in the modern data and to a sharp peak in the 1928 data (although both are attested in all categories for both era-groups). These prenuclear falls are further characterised by flat or falling pitch between the two (and often three) final turning points.

		REGION					LEGEND
TIMING		Kerry	Clare	Cork	Waterford	Tipperary	
ANTICIPATION	**Large** (-100< ms)	1%	4%	<1%	5%	4%	LEAST FREQUENT
	Moderate (-50-100 ms)	3%	10%	1%	16%	4%	
	Slight (-10-50 ms)	9%	22%	8%	24%	18%	
	On time (+/-10 ms)	7%	14%	7%	16%	20%	
DELAY	**Slight** (+10-50 ms)	15%	21%	17%	21%	33%	
	Moderate (+50-100 ms)	20%	10%	21%	8%	14%	
	Large (+100< ms)	45%	19%	45%	10%	6%	MOST FREQUENT

Table 20 *Summary of distribution of 1928 prenuclear accents across high-timing categories.Colour is used to indicate relative ranking of frequency, for ease of reference. This ranges from dark green (the most frequent category attested for a region) to dark brown (the least frequent category attested for a region), as laid out in the righthand legend.*

		REGION			LEGEND
TIMING		Kerry	Cork	Waterford	
ANTICIPATION	**Large** (-100< ms)	7%	16%	7%	LEAST FREQUENT
	Moderate (-50-100 ms)	9%	8%	12%	
	Slight (-10-50 ms)	36%	21%	34%	
	On time (+/-10 ms)	9%	7%	14%	
DELAY	**Slight** (+10-50 ms)	11%	8%	17%	
	Moderate (+50-100 ms)	6%	4%	6%	
	Large (+100< ms)	21%	35%	9%	MOST FREQUENT

Table 21 *Summary of distribution of 2020-21 prenuclear accents across high-timing categories. Colour-coding is used identically to as in Table 20.*

The picture is much the same for nuclear contours (Tables 22-23). Behaviour of nuclear accents' left peripheries was also seen to change between eras. Whereas straightforward initial rises before a high interval and subsequent fall were the emergent norm in the 1928 data, these have been displaced in the 2020-21 data by initial plateaux before an eventual fall.

HIGH TIMING		REGION Kerry	Clare	Cork	Waterford	Tipperary	LEGEND
ANTICIPATION	Large (-100< ms)	4%	11%	3%	15%	15%	LEAST FREQUENT
	Moderate (-50-100 ms)	6%	14%	5%	14%	12%	
	Slight (-10-50 ms)	12%	24%	11%	25%	21%	
	On time (+/-10 ms)	10%	13%	9%	12%	12%	
DELAY	Slight (+10-50 ms)	16%	14%	18%	16%	20%	
	Moderate (+50-100 ms)	14%	8%	18%	6%	15%	
	Large (+100< ms)	38%	16%	37%	11%	4%	MOST FREQUENT

Table 22 *Summary of distribution of 1928 nuclear accents across high-timing categories. Colour-coding is used identically to as in Tables 20-21.*

TIMING		REGION Kerry	Cork	Waterford	LEGEND
ANTICIPATION	Large (-100< ms)	13%	20%	10%	LEAST FREQUENT
	Moderate (-50-100 ms)	15%	8%	16%	
	Slight (-10-50 ms)	31%	19%	37%	
	On time (+/-10 ms)	9%	7%	12%	
DELAY	Slight (+10-50 ms)	11%	7%	12%	
	Moderate (+50-100 ms)	5%	5%	6%	
	Large (+100< ms)	16%	34%	8%	MOST FREQUENT

Table 23 *Summary of distribution of 2020-21 nuclear accents across high-timing categories. Colour-coding is used identically to as in Tables 20-22.*

These apparently position-independent findings are largely in line with what was seen for behaviour of pitch versus intensity in the statistical investigation of real-word syllable prominence at the lexical level in Chapter 5: a historical pattern of high F0 late-aligned with respect to intensity-prominence which was evident in 1928 Cork and Kerry – then relatively strong Gaeltacht heartlands with a high concentration of conservative speakers, including monolingual Irish speakers – has nearly disappeared. In its place, a pattern typified by closer alignment between intensity-prominence and high F0 – which previously characterised only Waterford and the now-extinct varieties of Clare and Tipperary – has emerged. Unlike for lexical-level pitch-prominence, however, speakers from Cork and Kerry still exhibit a substantial minority of heavily delayed high-pitch intervals with respect to intensity-prominent syllables in both prenuclear and nuclear positions, despite an overall move towards anticipatory high-pitch timing.

To conclude, at the phrasal level (i.e. looking at intonation over multiword utterances) there is ample evidence of heavily delayed high pitch with respect to intensity-prominent syllables, supporting a positive answer to RQ3. This is most robustly true of Cork and Kerry in the 1928 data, and still to a certain extent exhibited by modern speakers in the same regions. A pattern of closer alignment between intensity-prominence and high F0 previously evident only for Waterford and the now-extinct varieties of Clare and Tipperary has been retained in present-day Waterford and further become the numerically dominant pattern in Kerry and Cork. This supports the existence of regional variation in intonation within Munster, interrogated by RQ3a, and substantial change between the time that foundational dialect descriptions were written and the 21st century (RQ3b).

My working hypothesis, as for similar findings at the lexical level, is that this represents a more English/Germanic-like relationship between lexical and phrasal prominence, and between intonation and other prominence exponents (namely intensity and duration). This is supported by the apparent link between numerical and transmissional variety-strength and the prevalence of close alignment between intensity prominence and high F0. The historical dominance of lengthy delays in high-pitch achievement in what may be considered the 'reference' varieties of Munster Irish for the purpose of regional generalisations at the time of seminal dialectological descriptions' writing makes the possibility of at least some degree of Munster's purported 'shift' in PLP location in fact representing a misattribution of PLP location to the location of phrase-level pitch-prominence seem all the more credible. While it is possible that the late-aligned high pitch in 1928 Cork and Kerry are phonologically regular in their alignment with PLP (representing, for instance, the tail of an AM L*+H), this does not diminish the possibility of this high pitch's reinterpretation as marking PLP, whether by L1 speakers or L2 analysts.

Regrettably, these data to my knowledge represent the oldest available acoustic data on Irish; it is not possible to examine Waterford, Clare, or Tipperary Irish in a more robust, vital state before the geographical and numerical encroachment of English which was already well underway in 1928. Venturing briefly into pure conjecture, I believe that such hypothetical data (e.g. recordings of mid-19th-century Tipperary and Clare Irish) would show intonation patterns and timing more consistent with the 1928 Cork and Kerry recordings. The nearest equivalent which comes to mind are studies of intonation – and peak-timing in particular – of modern speakers of the Inis Oírr variety of Irish, which is typically said to bear more similarity to the Irish of nearby coastal Clare than to the more prototypically Connacht Irish of the other Aran Islands. Tantalisingly, Dalton and Ní Chasaide (2005) report substantial variability in the timing of high peaks in Inis Oírr in contrast to more fixed peak-timing in speakers from mainland Cois Fharraige. This itself raises two further questions: (i) how accurate are previous descriptions of intonation and alignment in other, non-Munster varieties of Irish? and (ii) which pattern of alignment between high F0 and metrically strong syllables is most closely representative of Old and Middle Irish intonation?

With regards to (i), the conceptually simple – if practically time-consuming – answer is to undertake parallel equivalent studies of intonation and PLP from archival and present-day recordings for other Irish varieties. With regards to (ii), then, there is simply insufficient evidence at present, and treatment of fine-grained phonetic questions for stages of the language predating the availability of acoustic data is bound to a certain degree of conjecture. However, for the purposes of interim theorising, I again refer to the rather dramatic geographical discontinuity between Clare on the western seaboard and Waterford/Tipperary much further east, compounded by the striking progression of Cork and Kerry Irish intonation, suspiciously concurrent with the decline of their geographical extent and numerical strength over the last century. The most straightforward common link between these geographically dispersed varieties, both for Waterford/Tipperary/Clare in 1928, and present-day Waterford, Cork, and Kerry is the relentless expansion of English as a dominant community language in all parts of Ireland. Nevertheless, a parallel, systematic survey of intonation data for other, non-Munster varieties of Irish would be of great theoretical and practical interest, no matter the outcome.

8 DISCUSSION AND CONCLUSION

In this final chapter, I bring together evidence from the empirical investigations presented in Chapters 4-7 to draw broader inferences about prosody in Munster Irish varieties at the lexical and phrasal levels. For ease of reference, each chapter is first summarised in brief in Section 8.1 along with its most important details and findings. This is followed by a treatment of Munster prosody, including most notably the implications of my findings for accounts of phonological lexical prominence in the region in Section 8.2. Finally, shortcomings of the present work and directions for future research are presented in Section 8.3, with concluding remarks in Section 8.4.

8.1 Structural summary of the thesis

Chapter 1 introduced the present thesis and provided a summary timeline for the development of the research enterprise. The three research questions concerning Munster Irish which drove the explorations of Chapters 4-7 were also presented. These interrogated the rhythmic behaviour of words' initial syllables (RQ1), the distribution of phonetic prominence markers across syllable positions and weight structures (RQ2), and the alignment of increased F0 with metrically strong syllables (RQ3).

Chapters 2 and 3 then provided crucial framing of pertinent topics, controversies, and gaps in the literature on prosody and the Irish language. In particular, the terminological ambiguities which continue to haunt the systematic, scientific study of prosody were influential in developing my approach to the present work. It is broadly accepted in the field that there is a need to distinguish between suprasegmental prominence at the level of the word and at the level of the phrase, in addition to attempts to tease apart the phonological from the paralinguistic.

Chapter 2 introduced pertinent cross-linguistic issues in prosody, most notably issues of lexical-level prominence. Individual lexical items in many languages are typically said to exhibit increased prominence on a single syllable – traditionally termed 'stress', 'accent', or some derivative of either or both. Authors vary with regards to which term refers to the abstract phonological feature of heightened prominence, and which refers to the phonetic realisation of that phonological mark. Further, the same terms may be applied with reference to phrasal prosody. This can make the comparison of theoretical claims about metrical structure, prominence, and prosody difficult between authors. The most typical solution – specifically defining what is meant by each term and any derivatives in the context of a particular work – is feasible, and allows for terminological continuity of a sort with the large historical body of scholarship on 'stress' and 'accent', but is ultimately unsatisfying. I took the decision, in line with suggestions by Hyman (2014) amongst others, to use explicit terminology: 'phonological lexical prominence' (PLP) for lexical-level single-syllable prominence that may be realised phonetically in a variety of ways cross-linguistically, as distinct from those realisations themselves ('phonetic prominences'), and phrasal prosody (chiefly intonation, but also, e.g., some durational changes).

Further, although PLP has often been casually assumed to be universal in its existence and application, there is an ever-growing body of evidence to suggest that languages vary a great deal in terms of (i) their reliance on this phonological feature, and (ii) its phonetic implementation within relevant languages (and varieties). Lexical distinctions based purely on contrasting syllable 'strength' alone are difficult to identify even in classical cases such as English or German, and languages such as French and Indonesian have been suggested to have no lexical-level phonological prominence at all. The latter can be perceptually cued for listeners with a strong-PLP L1 by phrase-level prosody, which is necessarily overlaid onto lexical material. This is closely linked to the problem of acceptable (or accepted) evidence for PLP in the first place.

Because of the terminological and cross-linguistic ambiguities in the identification and phonological role of lexical prominence, and in particular the thorny question of identifying the broad characteristic of increased 'strength' or 'effort' on a given syllable, several authors have identified the need to be sceptical of traditional descriptions of 'stress'/PLP location. Such descriptions are often found as part of grammars or dialectological descriptions, and rely on authorial impressions of relative strength in a language which may not be their L1. Further, they are virtually always indirect records; directly corresponding acoustic data are typically not available, and certainly are not when a description predates the widespread availability of recording technology.

These descriptions have their place, and often represent substantial scholarly undertakings. Problematically, however, they have frequently been assumed as valid 'data' for theoretical-analytical purposes by phonologists. Given the body of evidence presented in Chapter 2, and the works referenced therein, about the perceptual complexity of identifying PLP, and the cross-linguistic variation in its phonetic production and phonological utility, this is not a trivial problem. It borders on meaningless to theoretically 'account' for a given PLP system, or to reconcile it with a given theory of, e.g., universal requirements for metrical structure, if in fact the 'data' being accounted for are neither reliable nor directly observed by the analyst. Disclaimers to this effect in theoretical phonological papers are commendable, but the practice of using such 'data' nevertheless persists.

Munster Irish prosody presents just such a case, as introduced in Chapter 3. Work on Irish prosody to date can be divided into 'representative' British School sketches of typical phrasal intonation patterns as part of dialect descriptions in the early to mid-20th century, Autosegmental-Metrical analyses of intonation based on readings of sentence lists, and discussions of regional PLP. The latter centres around varieties of the language exhibiting PLP in non-initial position, in contrast to the more dominant demarcative system of initial prominence inherited from Old Irish. This is described as occurring on a lexical basis as far north as Mayo and in attested remnants of Leinster Irish, but is primarily associated with the Munster macrovariety. Hypotheses for the phenomenon's origin include O'Rahilly's (1932) suggestion of prolonged bilingualism and an influx of loanwords associated with Norman French, particularly in Munster, and Blankenhorn's (1981) proposal of high pitch occurring one or more syllables after PLP leading to the reanalysis of PLP location.

References to distinctive regional prosody in Munster involving PLP stretch back through and before the 19th century, but the details of the phenomenon of right-shifted PLP (or 'forward stress') vary considerably. For some authors, it is a feature only of disyllables with a long vowel in the second syllable, while for others it applies to items of any syllable count. Quantity-sensitivity was explicitly characterised as stemming from phonological weight in the 1990s, with long vowels and diphthongs defining heavy syllables, short vowels light syllables, and the sequence /ax/ as either variably heavy or having intermediate weight. PLP is agreed to be restricted to the first three syllables of a word, but competition between heavy syllables within that domain is unclear. Broadly speaking, initial syllables appear to be ignored for PLP purposes in the presence of heavy or /ax/ syllables.

Theoretical approaches aimed at reconciling such 'facts' of Munster Irish PLP with various phonological frameworks have generally taken dialectological/philological descriptions as their starting point. Most frequent among these are O'Rahilly (1932) and Ó Sé (1989, 2000, 2008). Using the catalogued lists of lexical classes and individual items and the associated author-perceptions of PLP location, authors then proceed to approach, e.g., the foot-structural status of initial syllables, representational status and weight-reckoning of /ax/, implications for metrical structure (such as Green's 1997 argument in favour of a universal requirement for the 'colon' constituent in the metrical hierarchy, between the foot and the prosodic word), and more recently the phonetic exponence of PLP. On the majority of these issues I am agnostic, for which reason I have devoted comparatively little space to their discussion.

The greater point of concern is the starting point for these analyses: the 'data'. The relied-upon descriptions of PLP location are purely impressionistic[20], and do not come with accompanying recordings; they further rely on an outdated classical notion of 'stress'/'accent' as universally understood, phonologically utilised, and perceptible 'strength' on a single syllable in a word. The descriptions themselves are useful; works such as Ó Sé's are meticulous in their detail, and certainly they indicate that one or more prosodic characteristics make these varieties of Irish distinct from their neighbours.

As a starting point, however, one cannot rule out that Irish prosody (especially before heavier contact with English from the early Modern period onwards) is or was not more French- or Indonesian-like in its relative indifference to PLP than English- or German-like. The curious and complex nature of the typically-described PLP system for Munster may be rather simpler if decomposed into lexical and phrasal components, and the light functional load of PLP in Irish lexical phonology is taken into account. PLP location is never lexically contrastive in Irish, and variability in PLP location for individual items (i.e. competing 'shifted' and 'unshifted' forms) is noted in in foundational literature on the topic (e.g. O'Rahilly 1932).

Chapters 2 and 3 thus framed my experimental approach to prosody in Munster Irish. The metronome-synchrony study of P-centre location in mutation-derived homophones presented in Chapter 4, although ultimately ill-fated (not least because of complications caused by the COVID-19 pandemic), was designed to address initial syllables in the variety (RQ1). The apparent defectiveness of these syllables, as noted above, is a prime feature of interest in treatments of PLP assignment in the region (cf. Iosad 2013). Phonetic effects involving syllable weight have been linked to P-centre location, which in turn is known to vary as a function of syllable onset-composition.

My interest was in whether the constant variation in the segmental composition of initial syllables in Irish due to the robust (and typologically rare) phenomenon of initial mutation could contribute to their unreliable weight status. Of course, as noted in Section 4.1, initial mutation characterises all varieties of Irish, and any link between this phenomenon and rightward movement of PLP would need to address the retention of historical initial PLP in most non-Munster varieties despite initial mutation.

[20]The cross-linguistically variable nature of PLP marking means that this is not a simple matter of phonetic training in auditory identification and description. Systematic description of, e.g., intensity, F0, vowel quality, and duration – which may mark PLP individually or in concert – is distinct.

Chapters 5 and 6 comprised parallel studies of the behaviour of various potential phonetic vectors for PLP-indication as a function of syllable position in di- and trisyllable words, addressing RQ2. These were undertaken, crucially, without assumptions concerning the location of PLP in all but light-light(-light) and heavy-light-(light) items with uncontroversial initial PLP in all varieties and stages of Irish. The aim was to systematically examine whether phonetic prominence(s) aligned with descriptions of 'shifted' PLP location in these varieties of Irish (RQ2), whether this was consistent across regions (RQ2a), whether things had changed between 1928 and 2020-21 (RQ2b), and whether shifted PLP obtained independent of lexical knowledge (RQ2c).

To this end, Chapter 5 examined prominence (intensity, F0 height and range, and vowel duration) for lexical items in naturalistic storytelling data from both archival recordings made in 1928 (roughly coeval with key dialect descriptions, and in some cases using the same informants) and in 2020-21. Chapter 6 used the same analytical and statistical methods to investigate nonwords with controlled weight structures elicited in prosodically controlled sentential contexts. These investigations jointly examined the extent to and consistency with which positional behaviour of the various prosodic parameters were affected by the weight-structural composition of items, and further how this varied synchronically and diachronically.

Finally, Chapter 7 presented a preliminary foray into intonation in Munster Irish, and the timing relationship between high pitch and metrically strong syllables. This was based on the same storytelling data used for Chapters 5-6. Eschewing a leap to Autosegmental-Metrical phonological labels for F0 contour-shapes – which may be interest for future work – this analysis focussed on phonetic features of F0 turning points, their scaling, and their timing. My interest as per RQ3 was in the relationship between intensity prominence and high pitch, with syllable intensity-prominence selected as a sufficient indicator of metrical 'strength' (though not necessarily PLP) for such exploratory purposes. Of particular interest were Ó Cuív's (1944) description of rise-fall runs in which high pitch was apparently out of phase with strong syllables, and Blankenhorn's (1981) related hypothesis about perceptual consequences of such 'misalignment'[21] of high pitch and metrical strength. As for Chapter 5, both synchronic (RQ3a) and diachronic (RQ3b) diversity were of interest.

[21]'Misalignment' in the basic sense of not being aligned. One of several plausible Autosegmental-Metrical analyses of such intonation patterns is a series of L*+Hs, in which metrically strong syllables are systematically associated with low tonal targets.

8.2 Discussion

The four investigations outlined above returned a number of interesting results with implications for the study of Munster Irish prosody going forward, as well as providing a case study on the importance of instrumentally and sceptically interrogating traditional language descriptions when data exist to do so. The scope of these issues is considerable, and it is my intention that the present work be taken as identifying areas of doubt worthy of further investigation, rather than providing conclusive new descriptions of or theories around these varieties of Irish and their prosody.

By far the most interesting results to emerge are those of the two lexical prominence investigations, within which two topics can be identified for further discussion: variance between observation and received descriptions/accounts of Munster PLP, and variation within the macrovariety itself. In the naturalistic data analysed in Chapter 5, it was undoubtedly the case that intensity, pitch, and duration measures were at times most prominent in a non-initial syllable. This was most evident in light-heavy and heavy-heavy disyllables, in which for 1928 speakers Bayesian linear mixed-effect models estimated wider F0 ranges and variably scaled F0 maxima in final position alongside ambiguous intensity-prominence. For prototypically shift-eligible light-heavy items, equivalent models for 2020-21 speakers estimated increases for intensity, F0 range, and vowel duration on the second syllable, alongside increased F0 and duration measures in heavy-heavy items (with ambiguous intensity). In these cases, there was broad (though not total) concord across regions within each era.

For trisyllables, evidence in favour of a consistent change in prominence location in any of the weight structures is perhaps even more questionable, and highlights regional splits in treatment of intensity and F0. It was only in 1928 speakers' light-heavy-/ax/ items that reliable estimates of medial intensity prominence were obtained in the joint posterior distribution of the relevant model (Model 2). Intensity in other heavy-medial trisyllables either favours initial position, or is equal between the first two syllables, apparently regardless of initial syllable identity. The behaviour of F0 range and height, while distinct between Kerry/Cork and Waterford/Tipperary/Clare in the 1928 data, was not obviously linked to item weight-structure. Model estimates were generally both modest and uncertain, indicating a lack of clear patterning in the data. Any slight positional differences in pitch height and range were therefore hypothesised to derive from phrase-level prosody independent of lexical prominence. For the 2020-21 trisyllable data, intensity prominence (Model 4) virtually always favoured initial position with the marginal exception of light-heavy-light items, and positional results for F0 range and height were ambiguous across all three regions.

It was also in the real-word data and models of Chapter 5 that the impact of high-frequency lexical items which exhibit idiosyncratic non-initial PLP in all varieties of Irish became evident, as these were seen to impact model results in favour of non-initial prominence for certain weight structures. This was most striking for light-/ax/ disyllables, in which initial model predictions aligned with received accounts of non-initial /ax/ attracting PLP. This apparently uniform effect became extremely heterogenous for intensity prominence in the 1928 data (Model 1b) and uniformly reversed direction in the modern data (Model 4b) when the adverbs *isteach* ‘in(side)’ and *amach* ‘out(side)’ were excluded from the input data. A similar reversal occurred for light-light-light items in the modern data when high-frequency *abhaile* ‘(at) home’ was excluded. This weight structure is not described as exhibiting PLP shift, but model results for intensity in the 2020-21 data (Model 4) initially estimated medial prominence. Once exceptional *abhaile* was excluded from the data, the revised model returned estimates in line with expected initial prominence for this category.

Regarding /ax/ in particular, this is an important finding. The trisyllable data do not support non-initial /ax/’s ability to attract prominence away from initial syllables. Disyllabic light-/ax/ is the best source of data on purported competition between these two syllable types, and final prominence does not appear to emerge unless linked to a very specific class of items represented by *isteach* and *amach*. The case could be made that the remaining items in the light-/ax/ category are third-person conditional verbs, and that basic PLP-assignment rules do not apply to morphologically derived items. However, faced with an analytical choice between lexically specifying PLP for a small class of items already known to have final prominence in other varieties, and attributing productive medium-heavy weight status to /ax/ syllables on the one hand while simultaneously requiring speakers to take verbal morphology into account during PLP assignment on the other, the former seems far more parsimonious.

The real-word data thus raised some serious questions about the phonetic and phonological details of PLP in Munster Irish, summarised below with a recapitulation of RQ2a-b. This was broadly in line with my initial impression when exploring the archival data – namely that intensity and F0 behaved differently, with the former tending towards a more conservative initial prominence – but did not unreservedly confirm my most extreme hypothesis as formulated in response to RQ2 (that statistical analysis of the 1928 data would show *no* shift in location of non-pitch prominence). Regional variation evident in both eras, though by far more pronounced in the 1928 data, undermine the notion of a unified ‘Munster’ prosodic system (RQ2a). Further, the robust differences seen between the two era-groups indicated the need for caution in assuming that data collected today is compatible with descriptions written a century or more ago, particularly given the increased influence of English on Irish (RQ2b).

RQ2: Do any phonetic prominence parameters align with descriptions of lexical prominence/'stress' location in MI?
***Hypothesis*:** One or more non-pitch parameters align with unshifted initial prominence (as in Ulster and Connacht), while salient pitch events align with non-initial syllables.
Finding: Mixed support for hypothesis. No prominence measure consistently favours /ax/ as medium-heavy or otherwise able to attract prominence to a non-initial syllable, but non-initial heavy syllables sometimes attract intensity prominence. Divergence between intensity and F0 prominence was common, especially in the 1928 data.

RQ2a: Are lexical prominence patterns consistent across Munster subvarieties?
***Hypothesis*:** Regional varieties differ from one another.
Finding: Hypothesis supported. Regional variation is evident in data from both eras.

RQ2b: Have lexical prominence patterns in MI changed between 1928 and the present day?
***Hypothesis*:** 1928 speakers have distributed/ambiguous prominences, while present-day speakers show more straightforward 'shifted' prominence under expected conditions.
Finding: Mixed support for hypothesis. Change between the two eras has definitely occurred. Conservative 1928 speakers from Cork and Kerry showed (limited) weight-sensitive intensity prominence, with weight-insensitive F0 height, while Waterford/Tipperary/Clare speakers showed closer coordination across prominence-types. 2020-21 data for Cork, Kerry, and Waterford show the latter tendency.

Equipped with this basic scepticism of received accounts of Munster PLP, we can consider the findings of the other analyses presented. I turn first to the P-centre experiment presented in Chapter 4, conducted largely before this scepticism was fully developed. Starting from the assumption that received accounts of Munster PLP were correct, the data collected were intended to evaluate the segmental and rhythmic features of word-initial syllables. Insofar as the results of the study – summarised with reference to RQ1 below – were informative, the most useful findings were that (i) mutation-derived homophones did not show evidence of being rhythmically distinct from one another under the available metrics, and (ii) that syllables' vowel durations may fluctuate as a function of onset duration. The latter is of marginal interest from the perspective of syllable weight. The onsets of initial syllables in Irish are subject to constant change in terms of place/manner of articulation and voicing/aspiration as a result of both nominal and verbal initial mutation. Given evidence in the literature that alignment of tonal targets may vary with onset identity and vowel duration (see Chapter 2.4), it is plausible that initial syllables in Irish could be – at least variably – unstable for intonational alignment.

> **RQ1:** Does initial mutation contribute to the apparent phonetic/phonological instability of word-initial syllables in Munster Irish (MI)?
> ***Hypothesis:*** Duration of onsets is unaffected by mutation, while syllable rhymes are. The latter makes initial syllables unstable for weight-reckoning purposes within individual lexical items.
> ***Finding:*** Mixed support for hypothesis. Onset durations were clearly consistent within phoneme categories, with no evidence for an effect of mutational status. Vowel durations were not obviously affected by mutation status either, but there is marginal evidence of a negative relationship with onset duration. Changes in onset consonant due to mutation may thus indirectly (and minutely) affect vowel duration in initial syllables.
>
> > **RQ1a:** In terms of P-centre location, do mutated items align with their unmutated/radical counterparts, or with their segmental matches?
> > ***Hypothesis*:** Mutated items align with their lexical matches, rather than with their homophones (e.g. the P-centre of *bpá* matches that of *pá*, not that of *bá*).
> > ***Finding:*** Hypothesis not supported.

Looking then to the results of Chapter 6’s nonword production task, there was a clear mismatch between participants’ treatment of more weight-sensitive intensity-prominence and less category-variant features of F0, vowel quality, and duration. Intensity-prominence was estimated to occur on the leftmost heavy syllable for Cork and Kerry participants and two of three Waterford ones, while a single Waterford participant (DE2) placed intensity-prominence on medial heavy syllables regardless of surrounding context and medial /ax/ in items without heavy syllables. This split between participant DE2 and the other 11 participants in the task also emerged for Models 19-22 of F0 height and range, showing higher F0 maxima and wider ranges in medial position for DE2 versus in final position for all other participants. In general, these findings support a mismatch between intensity- and F0-prominence in these varieties, in line with previous preliminary findings by Windsor *et al*. (2018). This adds additional support to the hypothesis of regional variation proposed for RQ2a.

In general, the nonword results suggest that when confronted with unfamiliar (pseudo)lexical targets, speakers of modern Munster Irish varieties are inclined to apply a single, default intonation pattern to items of a given syllable-count, independent of which syllable is intensity-prominent. Intensity-prominence is then seen to be possibly weight-sensitive, but apparently restricted to the first two syllables of a target, subject to regional variation. Vowel duration and quality, meanwhile, do not seem to indicate alignment with PLP location. There was an apparent tendency for vowel lengthening in final syllables, regardless of item weight-structure, and vowel height and backness seemed to be affected by adjacency to /x/. These findings are summarised below with reference to RQ2c.

> **RQ2c:** Do present-day MI speakers productively produce non-initial prominence in items they have never pronounced before?
>
> ***Hypothesis*:** Speakers are more likely to show variability in assigning prominence to nonwords than consistent patterns aligning with predicted prominence shifts.
>
> ***Finding:*** Mixed support for hypothesis. With the exception of DE2 showing a distinct pattern, participants were generally consistent in their strategies of prominence-assignment for various weight structures. For intensity, this included apparent sensitivity to presence/distribution of non-initial heavy syllables, but did not support productive medium-heavy weight for /ax/. Changes in F0 height and range were largely category-invariant.

Results of the nonword experiment suggest that speakers may indeed place PLP on a non-initial heavy syllable. In line with real-word findings from Chapter 5, however, there was no evidence of /ax/ syllable productively acting as heavy or medium-heavy in neither second nor third positions; this lends support to an account of non-initial /ax/ PLP described in the literature as a limited, lexically-specific phenomenon, rather than a productive part of the Munster prosodic system. Intensity appears to be the best candidate for a PLP-location diagnostic tool, given its observed movement as a function of weight structure, while the structure-invariance of pitch phenomena within syllable-count categories would suggest a phrase-level implementation.

Phrase-level intonation was then examined in Chapter 7, in which it became evident that – in the context of largely (rising-)falling contours in almost entirely declarative sentences – the relationship between increased F0 and metrically ‘strong’ syllables defined by intensity-prominence was subject to regional (RQ3a) and diachronic (RQ3b) variation. In what is stipulated to be the most conservative data, collected from the Kerry and Cork Gaeltachtaí in 1928, by far the most common pattern was for the achievement of high pitch in a described contour to occur 100 milliseconds or more after the midpoint of the intensity-prominent syllable. This was not shared by contemporary Waterford, Tipperary, and Clare speakers who, while undoubtedly exhibiting variability in high-pitch alignment, generally had high-interval onsets beginning within 50ms of the strong-syllable midpoint (in either direction). Recall from Chapter 5 that although estimates for F0 behaviour were somewhat vague for trisyllables, in disyllables 1928 Kerry and Cork speakers showed invariant higher pitch in final position, while Waterford, Tipperary, and Clare speakers showed higher F0 on intensity-prominent syllables.

In the modern data, measurements for all three regions showed high-interval onsets occurring within 50ms of strong-syllable midpoints in the majority of cases, although Cork and (less pronouncedly) Kerry speakers still exhibited a sizable minority of large (100+ ms) delays. Findings from Chapter 7 are summarised with reference to RQ3 below, thereby completing the list of research questions and hypotheses outlined in Chapter 1.

> **RQ3:** Does high pitch in intonation contours align with metrically strong syllables?
> ***Hypothesis*:** High pitch often occurs one or more syllables following metrical strength.
> ***Finding:*** Hypothesis supported. Stable high-F0 regions began 100+ ms after the midpoint of metrically strong syllables' vowels as a matter of course in Cork and Kerry data from 1928. In data from the other 1928 regions, closer alignment between high F0 and intensity-prominent syllables is the norm. The same is true of the 2020-21 intonation data, but a significant minority of large delays between intensity-prominence and high F0 are still attested in Cork and Kerry (see RQ3a below).
>
> > **RQ3a:** Is intonation (including alignment) consistent across Munster subvarieties?
> > ***Hypothesis*:** Regional varieties differ from one another.
> > ***Finding:*** Hypothesis supported. Different high-F0 timing emerged across regions.
> >
> > **RQ3b:** Has intonation (including alignment) changed between 1928 and the present day?
> > ***Hypothesis*:** Present-day speakers exhibit more influence from English prosody.
> > ***Finding:*** Hypothesis supported*. Intonation data from 2020-21 shows closer alignment between high F0 and intensity-prominence, previously seen for a subset of varieties already under pressure from English in the 1928 data and not observed in the 1928 data for then-conservative Cork and Kerry. This could evidence a move towards English/Germanic-type culminative coordination of lexical- and phrase-level prosody, consistent with growing dominance of English in Irish-speaking regions.
> > (*Subject to conflicting evidence from nonword production, discussed below).

Considering the timing of the shift away from Irish-language dominance towards universal contact with English in each of these regions, it is possible to hypothesise about the development of Munster prosody over the last two centuries. If the 1928 data for Cork and Kerry are taken as the most conservative available recordings of Munster intonation – and, to my knowledge, no older wax cylinder recordings than these exist – then it stands to reason that the robust pattern of high F0 occurring one or more syllables after intensity-prominence represents the historical norm for the region. The intonational resemblance despite geographical discontinuity between Waterford/Tipperary and Clare speakers would be easily reconciled with a shift towards English-like alignment between lexical and phrasal prominence, coinciding with an earlier decline in Irish's dominance as a community language in these Munster subregions (only one of which still has a Gaeltacht today). Similarly, the change evident in present-day Cork and Kerry data towards a pattern more in line with 1928 Waterford/Tipperary/Clare would line up with the largely unchecked expansion of English in these two historically conservative regions.

To this, however, must be added a caveat in light of the findings for nonword production in Chapter 6. While these results for phrase-level measurements of temporal coordination between increased F0 and intensity-prominence may provide support for English-type alignment between intonation and PLP, results for nonword production showed F0 patterns which were largely insensitive to an item's weight structure, despite weight-sensitive intensity-prominence moving. There is insufficient evidence from these data to account conclusively for the intensity/F0 independence indicated by nonword production and close temporal affiliation between intensity-prominence and increased F0 seen in the modern intonation data. Further interrogation of context (highly controlled in the nonword task, but variable in the intonation data) is needed as a first step.

8.2.1 General implications of findings

Turning then to consider the phenomenon of Munster Irish PLP, and its apparent rightward shift under various conditions, the above findings from multiple angles of prosodic inquiry should give pause. Most conclusively, I see no evidence to support an exceptional status for /ax/ in Munster Irish weight-reckoning or PLP assignment; cases of non-initial /ax/ receiving suprasegmental prominence are more easily reconciled with lexical specification, and segmental effects of duration and quality seem more obviously contextual than phonological-prominential. Beyond this, it is from my perspective unproblematic to simply cast doubt on received accounts rather than to make strong positive claims.

The greatest source of this doubt is observed variation across and within regions at various points in the analyses of Chapters 4-7. Foundational dialectological accounts make reference to similar regional and individual variation, and competition between 'shifted' and 'unshifted' PLP patterns for shift-eligible lexical item. Formal phonological accounts of the 'facts' lifted from these descriptions, however, overwhelmingly tend to treat descriptions of non-initial PLP in the region as conclusive and uniform in its occurrence. The degree of variability evident in the this thesis's analyses of lexical and phrasal prosody make it difficult to accept the representativeness of limited data previously used in examinations of the region's prosody. Previous instrumental-phonetic approaches to Munster prosody have relied on recordings collected from small numbers of speakers. Further, the accounts of PLP location in the region used for reference were built in layers over the 19th and 20th centuries, during which time far more prosodically conservative varieties were likely to be heard by scholars, at the very least in greater number than can be found today. Synchronic and diachronic regional variation evident in Chapter 5-7 underscore why this is highly problematic.

The evidence mustered in Chapters 5-6 support that non-initial heavy syllables can attract PLP in Munster Irish varieties. Meanwhile, there is clear evidence of a historical preference in Cork and Kerry for very late-aligned high pitch with respect to intensity-prominent syllables which has diminished but not disappeared in present-day data. I suggest that, in line with Blankenhorn (1981), such late-aligned high pitch could have cued the perception of right-shifted PLP even where intensity-prominence continued to occur in initial position. However, it is conceivable that this misperception is at least in part attributable not to historical Munster Irish speakers so much as to scholars attempting to describe PLP location with a Germanic 'ear' (whether by L1 or by training). This additional layer of confusion is proposed to account for the origin in the literature of the more elaborate features attributed to Munster PLP, as the data from both real- and nonword prominence suggest a far more limited system of prominence on heavy syllables in second position (with some variation).

Regarding the various theoretical phonological issues on which evidence from Munster Irish has been brought to bear, it is not my intention to make comment. For instance, regarding the issue of the construction of metrical feet, and the headedness of such feet (especially in initial position), the present work does not provide particularly well-suited data or analyses. If it is indeed the case, as apparently observed, that in perhaps more limited cases than previously described, PLP consistently occurs in non-initial position only in the presence of non-initial heavy syllables, then in the context of a theory espousing obligatory and universally available foot structure, weight-sensitive competition between PLP in initial and peninitial position is of interest. However, more central to the argument I have presented is that, at a more basic level, the current state of instrumental phonetic and systematic phonological knowledge about Munster prosody is *insufficient to be considered acceptable 'data' for these theoretical arguments*.

The present work is therefore a decidedly phonetic one, albeit entailing general phonological and historical-linguistic interests. Phonological accounts advanced concerning initial-syllable defectiveness, foot-construction, and head-directionality in these Irish varieties may incidentally be correct; equally, the more elaborate ‘problematic’ features which have attracted interest may not reliably emerge under systematic phonetic study with adequate quantities of acoustic data. It is also to a certain extent a matter of theoretical preference whether one accepts the obligatory nature of PLP and the character of its signalling and perception. Certainly in the Irish lexicon, even under sustained pressure from English, PLP location is not remotely contrastive, raising serious questions about its functional load. The extent to which Munster’s prosodic distinctiveness is best understood as a series of lexical specifications and analogical extensions is an open question.

8.3 Directions for future work

The present thesis has focussed nearly in its entirety on Munster varieties of Irish, the initial motivations for which have been made abundantly clear. However, the most pressing direction for future work which this raises is the equivalent examination of lexical and phrasal prosody in other varieties of Irish. In particular, this is needed in order to assess the Munster-specificity of non-initial PLP patterns found in the nonword-production task of Chapter 6; this, in turn, would inform the consideration of the latter’s productive versus analogical status, as well as its relationship to diachronic change in the language. The Doegen Records contain storytelling data parallel to that examined for Munster for Connacht and Ulster Irish varieties in the 1920s, and this is an area ripe for exploration and comparison with the present Munster study.

For the study of PLP in particular, it is of great interest whether the phonetic prosodic ambiguities observed in the 1928 Munster recordings have parallels in contemporary speakers from other Gaeltacht regions. The prosodic divide separating Munster from Ulster and Connacht could entirely plausibly emerge as a phrase-level characteristic of intonational alignment with metrical strength which, once controlled for, reveals similarly ambiguous lexical-level prosody in these other varieties. Similarly, the degree to which non-initial PLP can be observed in modern speakers of non-Munster varieties in nonword production – as has been documented for real words, e.g., Mayo Irish by Ó Sé (1989) – would provide an interesting perspective on non-initial PLP as either a Munster phenomenon or the result of increasingly English-like prosody in present-day Irish.

Within the Munster varieties themselves, there remains a great deal to be done. As has been emphasised at numerous points over the preceding chapters, the present work has been basically exploratory and should be seen as a starting point for future bottom-up, data-driven study of prosody in the region’s Irish varieties, both past and present. Following preliminary studies of mode- and context-controlled intonation in Kerry by Dalton and Waterford by myself, Cork Irish still requires study in this area. Only so much can be done on intonation from a historic and diachronic perspective, given the limits on the available archival data, but nevertheless, instrumental analyses of archival recordings can be compared with older British School descriptions where applicable. To the extent that this has been possible with the data collected for the present work, interesting correspondences have emerged between Ó Cuív's (1944) impressionistic aural descriptions of Múscraí intonation and the patterns of alignment observed for Cork Irish in both 1928 and the present day.

In short, future work on prosody in Munster, and in Irish more generally, should take advantage of available archival data – including from later in the 20th century than that of the Doegen Records – using modern instrumental-phonetic and corpus-linguistic techniques. This can, and should, be complemented with the systematic collection of data from modern speakers – particularly given the sociolinguistic pressures facing Irish in the Gaeltachtaí and beyond. The present work demonstrates the need to critically interrogate received dialect descriptions, and to consider ongoing changes at play. While the focus here has been on prosody, and most critically surrounding accounts of PLP, this is in principle applicable to segmental phonology as well.

Beyond Irish, I hope to have contributed to the body of phonetic and laboratory-phonological work supporting the need to be more critical in the evaluation of acceptable 'data' for theoretical treatment, in terms of both quality and quantity. Future work on phonological lexical prominence in particular can only benefit from approaching its data with due rigour. This in its own way then relates to treatments of intonation, especially the creation of AM-style pitch-accent inventories, which rely on the identification of PLP location for definitional purposes.

8.4 Conclusion

This thesis has examined the prosodic characteristics of the Munster macrovariety of Irish, covering L1 Irish speakers from the historical and present Gaeltachtaí of Counties Kerry, Cork, Clare, Waterford, and Tipperary of two eras (1928 and 2020-21). The dialect group in question has previously received limited treatment regarding its intonation, and more notably has attracted attention with what has been described as a complex, weight-sensitive system of phonological lexical prominence. The research enterprise became 'structural' in the course of investigating the relationship between lexical and phrasal prosodic prominence, and systematic positional and compositional effects on phonetic exponents of such prominence. In the spirit of the Bayesian approach taken to the statistical portions of the relevant analyses, it has been my goal to explore plausible parameter spaces in as systematic a manner as possible, in order to lay the foundations for more sophisticated future work.

A long history of terminological ambiguity and overreliance on impressionistic descriptions based on limited hard data combine with the results of the presented studies of (i) initial-syllable rhythmic and segmental characteristics (Chapter 4), (ii) positional behaviour of various potential prominence-markers in real and nonword items of different weight-structures (Chapters 5-6), and (iii) intonational alignment (Chapter 7), to warrant caution in simply accepting previous accounts of prosody in the region. Going forward, researchers must carefully consider the phonetic facts before leaping to theoretical claims on the basis of temptingly exotic, but often borderline anecdotal, accounts of relevant phenomena.

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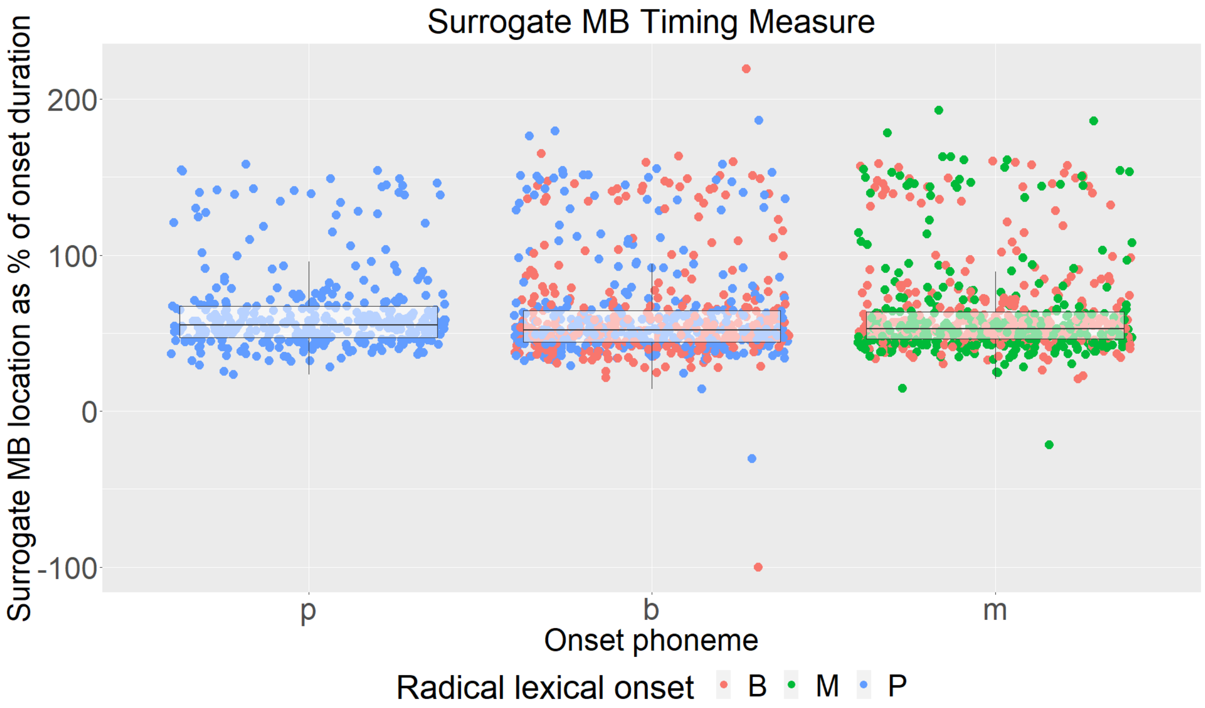
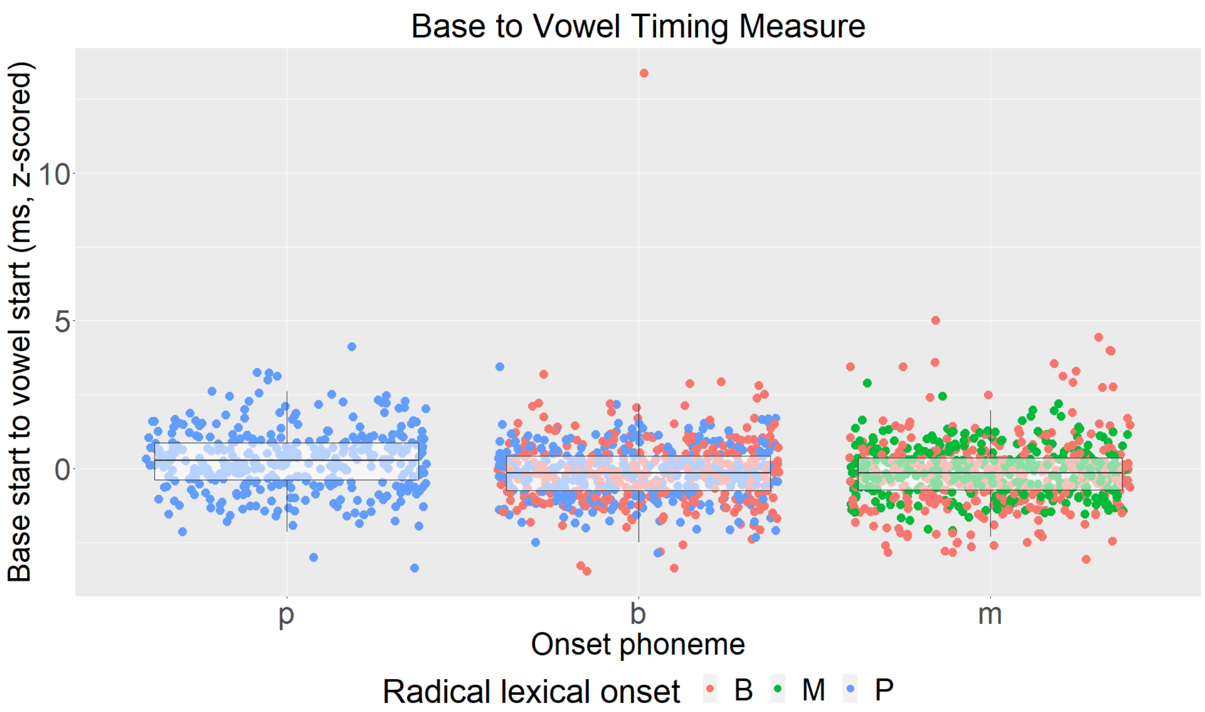
Appendix A: Supplemental materials for Chapter 4

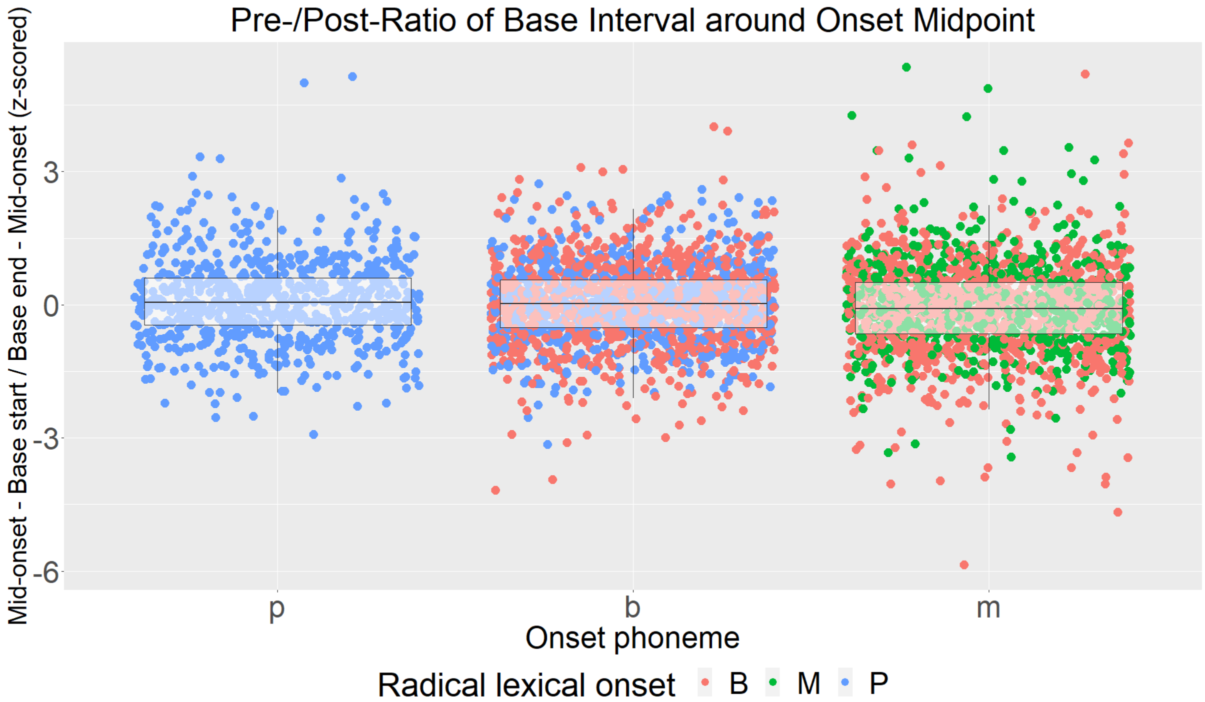
Candidate timing measures (Section 4.3.2, pp.84-85):



Page 84: *Distribution of surrogate metronome beat timing measure, for which the midpoint of the base interval (a proxy for the metronome beat nearest the target) is measured as a percentage of a target's onset duration. A lower percentage indicates an earlier P-centre. No appreciable difference is evident across categories.*



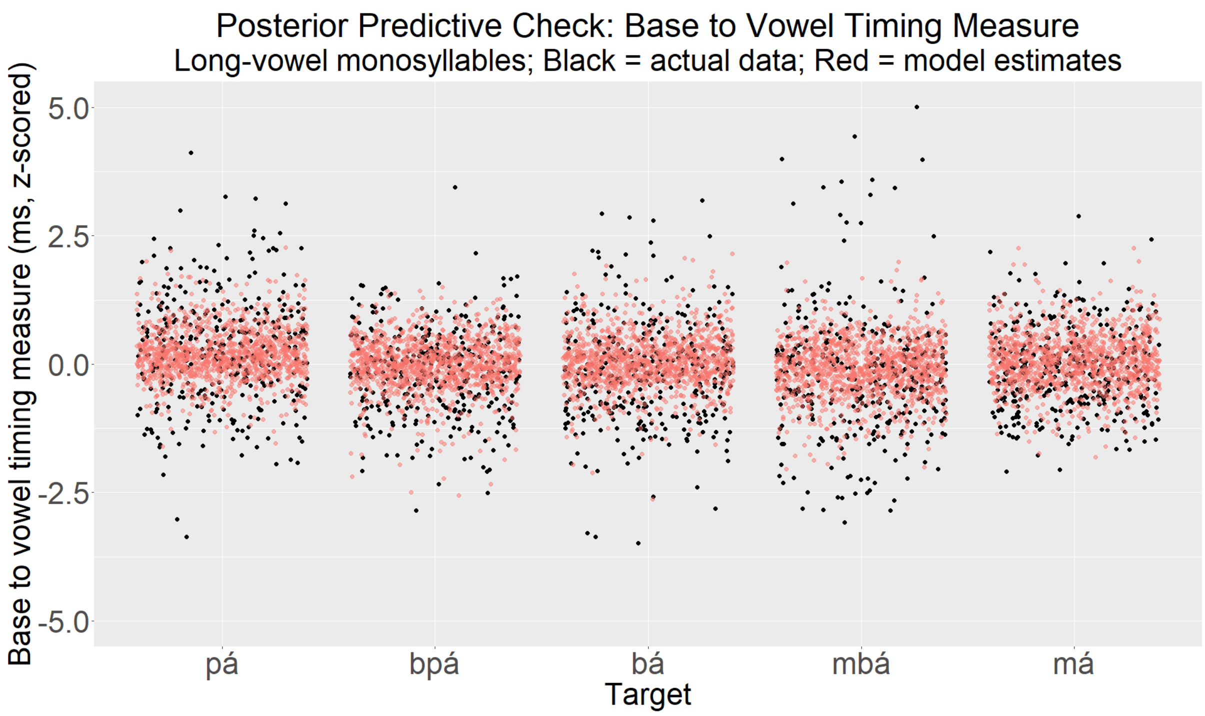
Page 85: *Distribution of base-to-vowel timing measure, using the duration between the beginning of the base interval and the onset of the target vowel. The duration has been z-scored by speaker. A longer duration indicates an earlier P-centre. Earlier P-centres for onset /p^{γ}/ than for /b^{γ} m^{γ}/ appear to be reflected.*



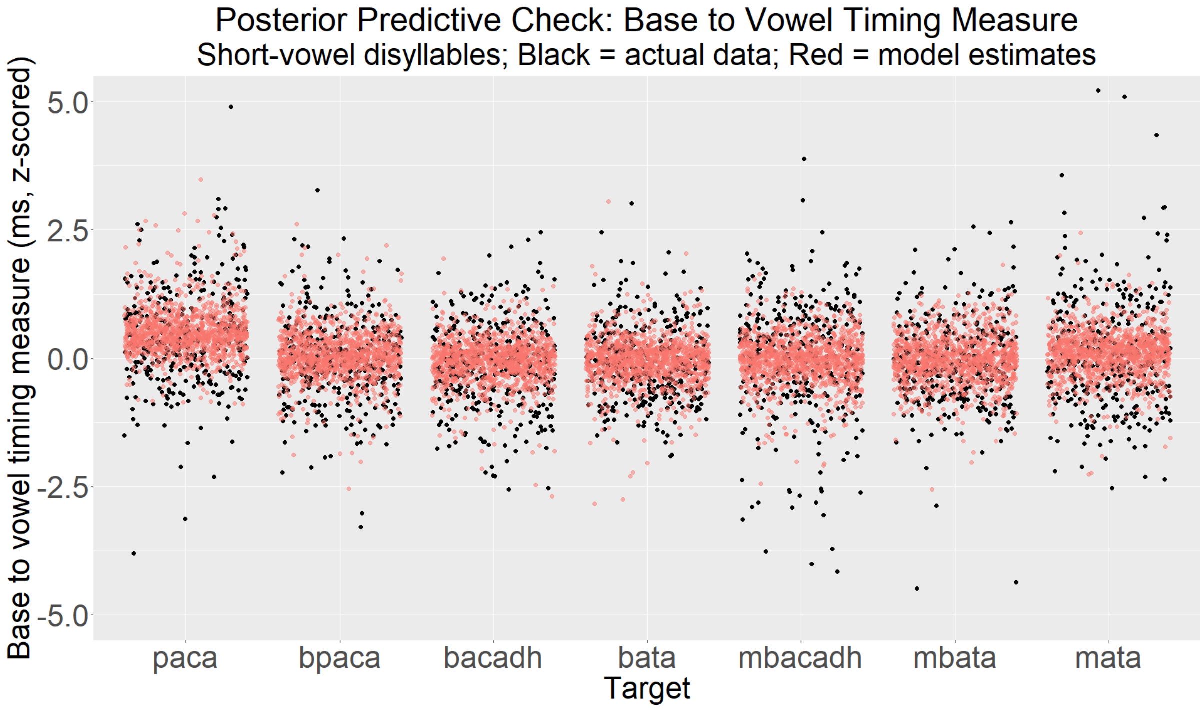
Page 85: *Distribution of ratio-based timing measure, using a ratio of the duration between the beginning of the base interval and the midpoint of the target onset to the equivalent duration between the onset midpoint and the end of the base interval. The ratio has been z-scored by speaker. No appreciable difference is evident across categories.*

Model of timing measure (Section 4.3.4 p.91):

Base-to-Vowel ~ Onset phoneme + Lexical ID + Mutation status + Onset <bp> + Onset <mb> + Onset duration + Vowel duration + Token duration + (All | Speaker) + (All | Length category)



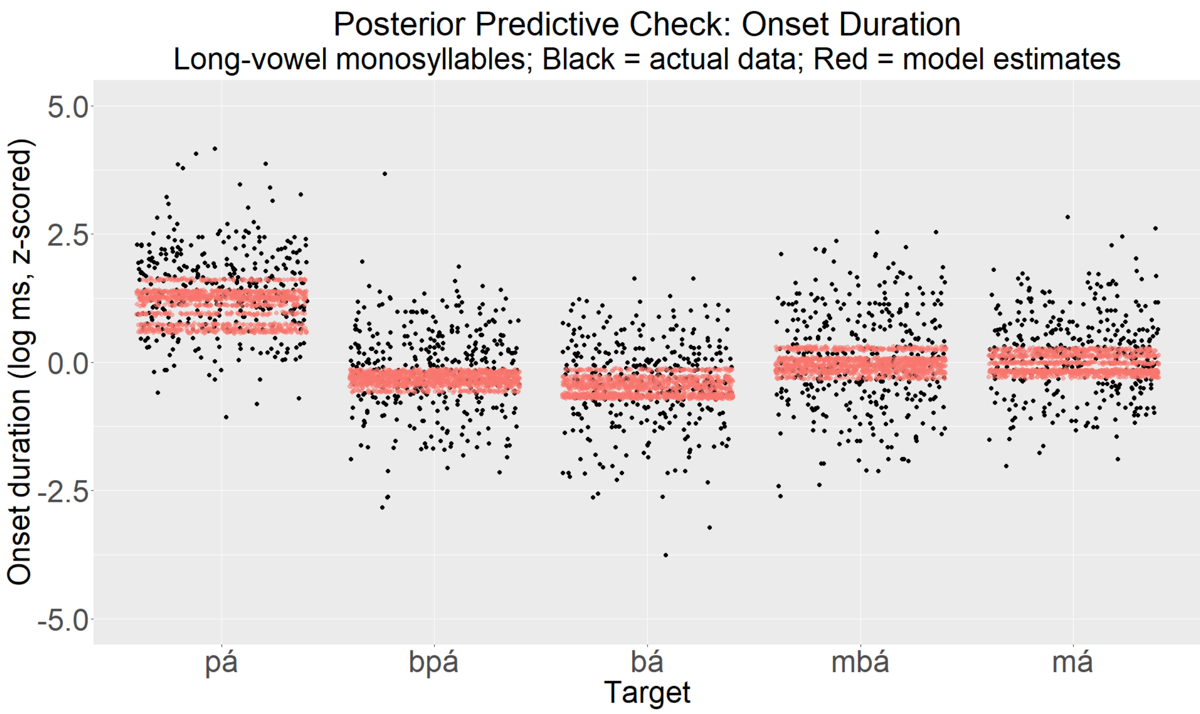
Page 91: *Posterior predictive check for the model of base-to-vowel timing measure as a function of onset identity, lexical identity, mutation status, mutation status in interaction with onset identity, onset duration, vowel duration, and whole token duration. Model predictions for long-vowel monosyllables align with values actually observed in the data.*



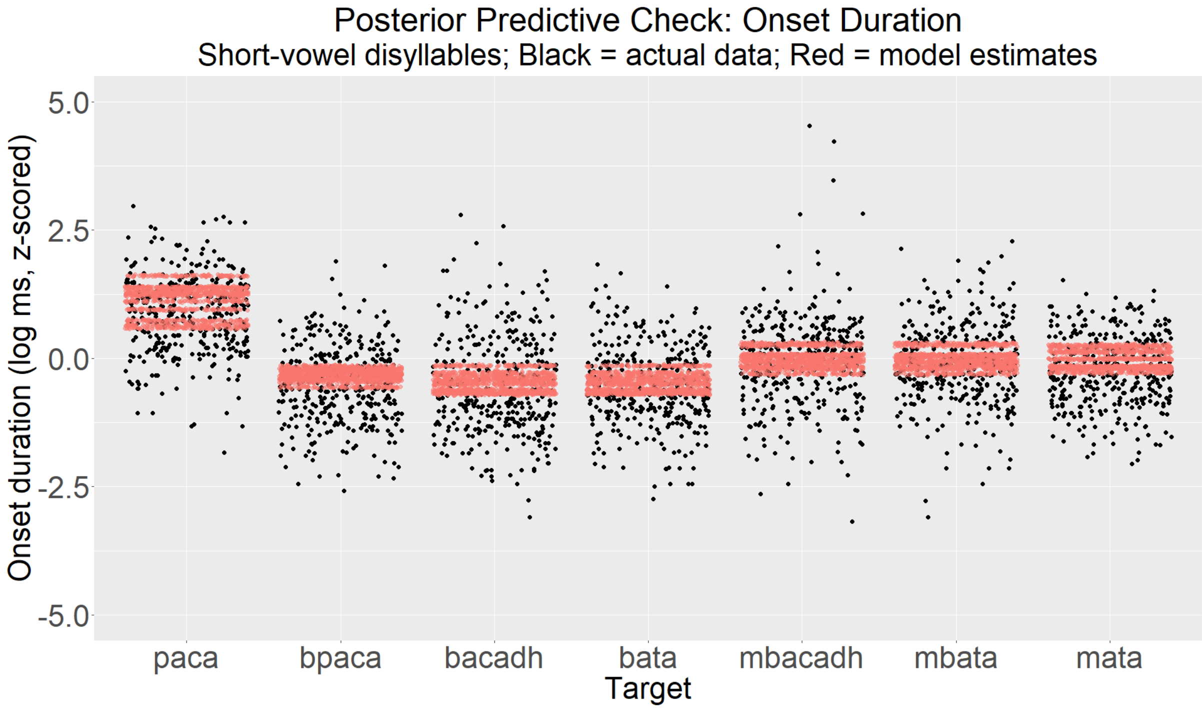
Page 91: *Posterior predictive check for the model of base-to-vowel timing measure as a function of onset identity, lexical identity, mutation status, mutation status in interaction with onset identity, onset duration, vowel duration, and whole token duration. Model predictions for short-vowel disyllables align with values actually observed in the data.*

Model of onset duration (Section 4.3.5, p.98):

Onset duration ~ Onset phoneme + Mutation status + Onset <bp> + Onset <mb>
+ (Onset phoneme + Mutation status | Speaker)



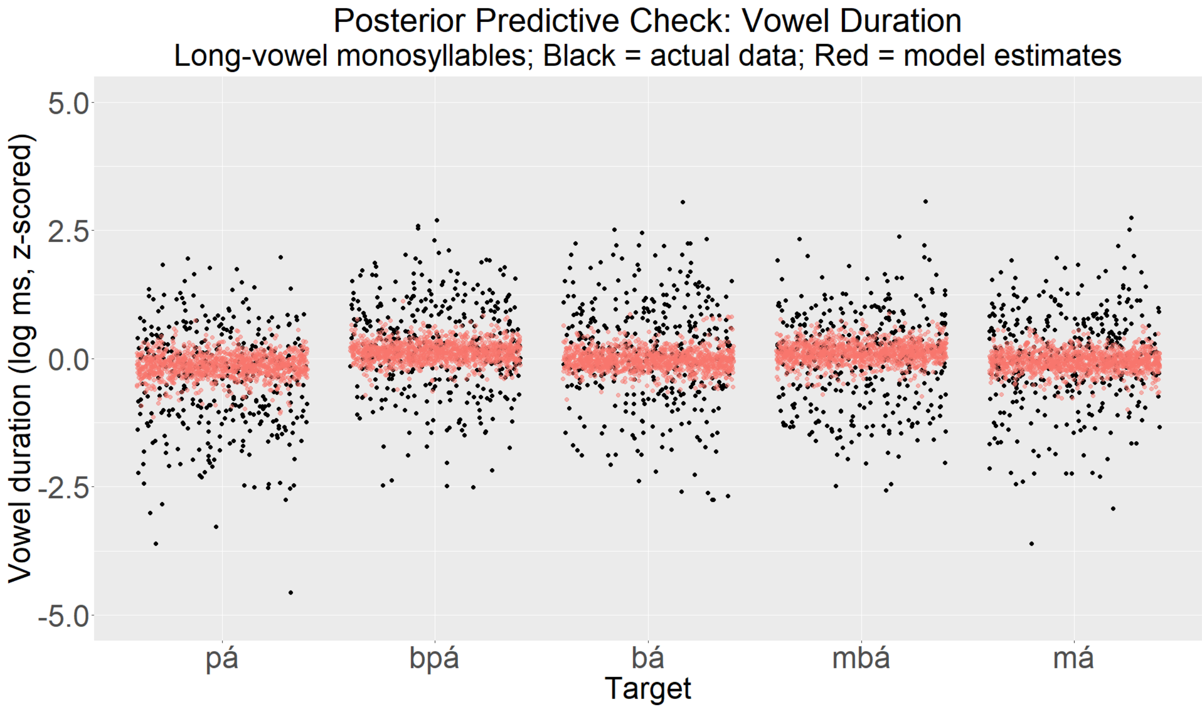
Page 98: *Posterior predictive check for the model of onset duration as a function of onset identity, mutation status, and interaction between these two predictors. Model predictions for long-vowel monosyllables align with values actually observed in the data.*



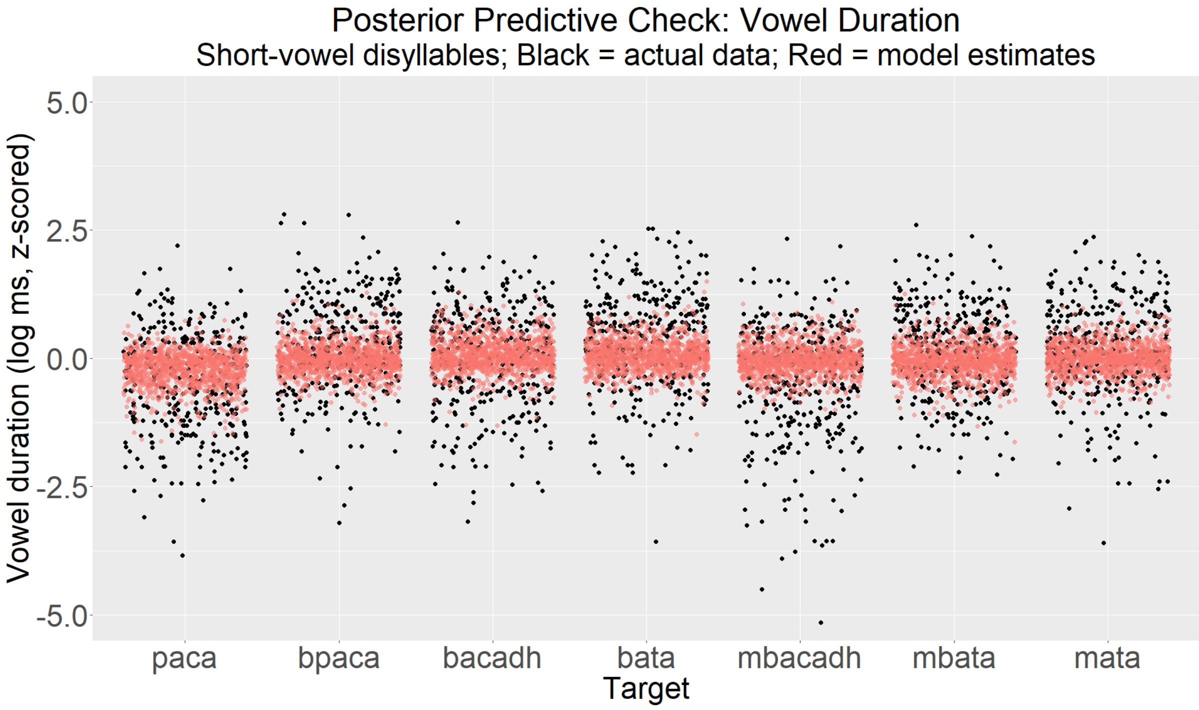
Page 98: *Posterior predictive check for the model of onset duration as a function of onset identity, mutation status, and interaction between these two predictors. Model predictions for short-vowel disyllables align with values actually observed in the data.*

Model of vowel duration (Section 4.3.6, p.100):

Vowel duration ~ Onset duration + Base-to-vowel timing measure + Mutation status
+ (All | Speaker) + (All | Length category)



Page 100: *Posterior predictive check for the model of vowel duration as a function of onset duration, target timing and mutation status. Model predictions for long-vowel monosyllables align with values actually observed in the data.*



Page 100: *Posterior predictive check for the model of vowel duration as a function of onset duration, target timing and mutation status. Model predictions for short-vowel monosyllables align with values actually observed in the data.*

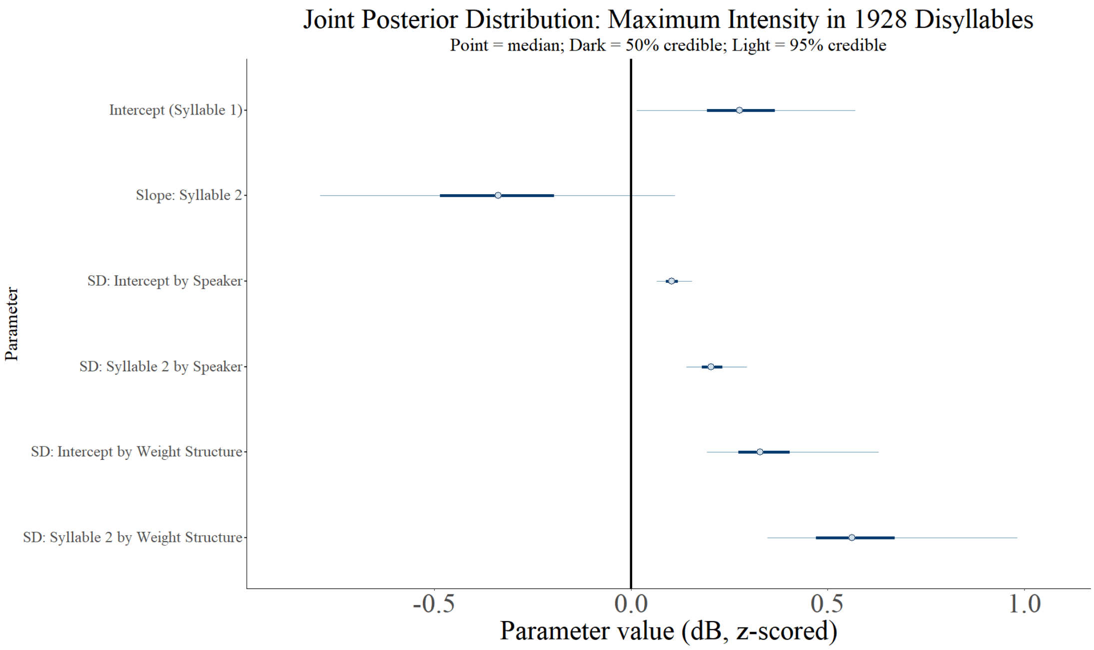
Appendix B: Supplemental materials for Chapter 5

All disyllable models: MEASURE ~ Second syllable + (Second syllable | Speaker)
+ (Second syllable | Weight structure)

All trisyllable models: MEASURE ~ First syllable + Third syllable + (Both | Speaker)
+ (Both | Weight structure)

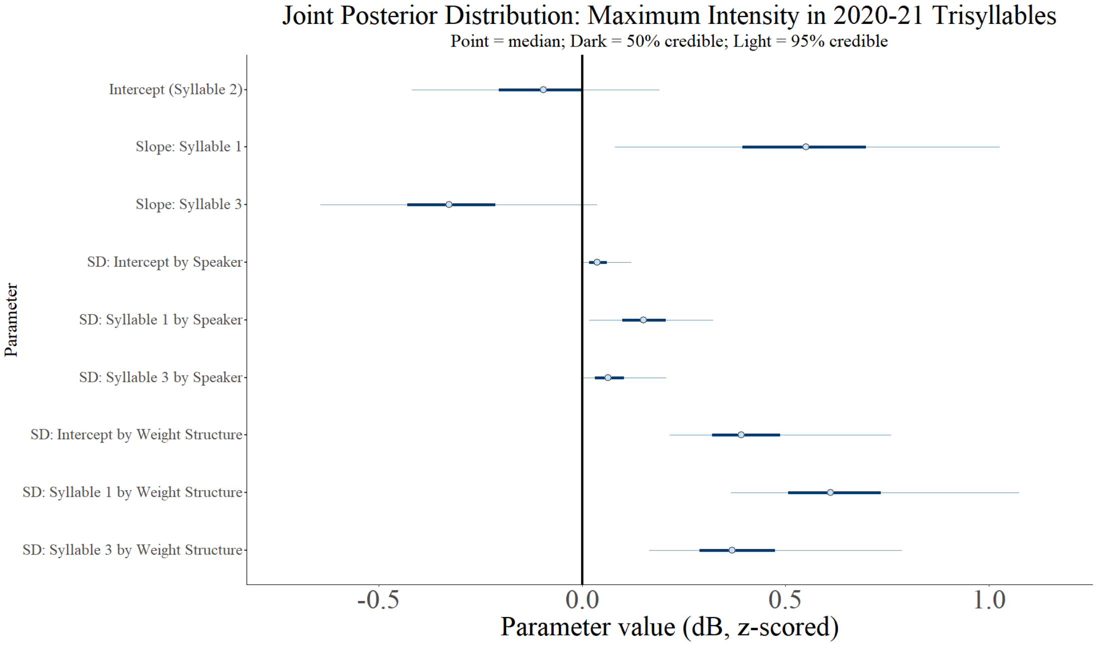
Models 1-4, Maximum Intensity (Section 5.2.1):

Model 1, 1928 Disyllables (pp.119-120):



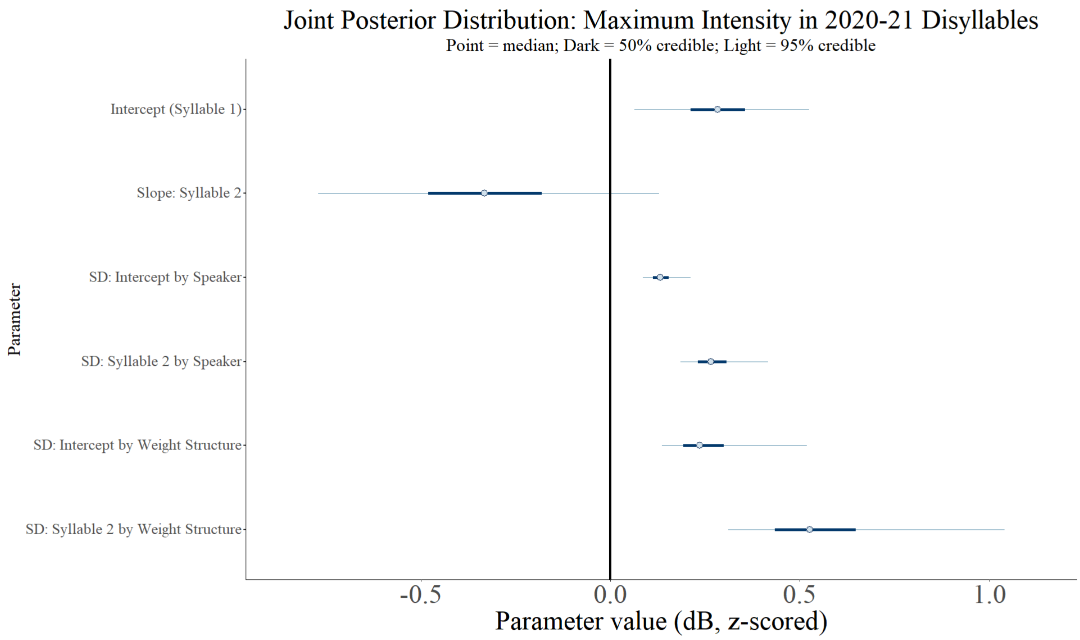
Pages 119-120: *Joint posterior distribution for Model 1 (maximum intensity in 1928 disyllables).*

Model 2, 1928 Trisyllables (pp.124-125):



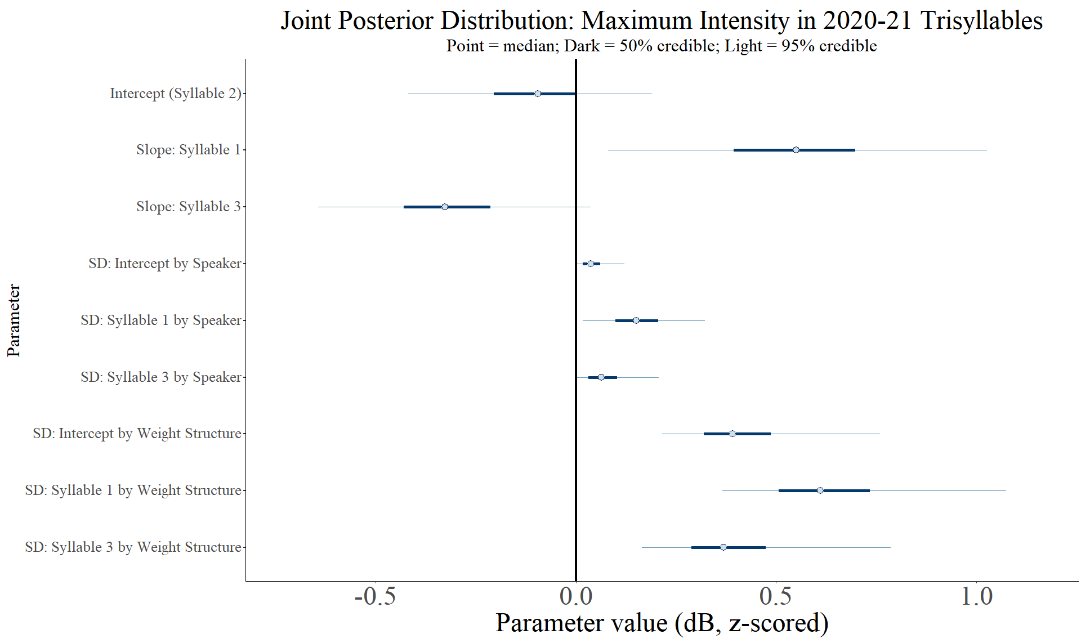
Pages 124-125: *Joint posterior distribution for Model 2 (maximum intensity in 1928 trisyllables).*

Model 3, 2020-21 Disyllables (pp.126-127):



Pages 126-127: *Joint posterior distribution for Model 3 (maximum intensity in 2020-21 disyllables).*

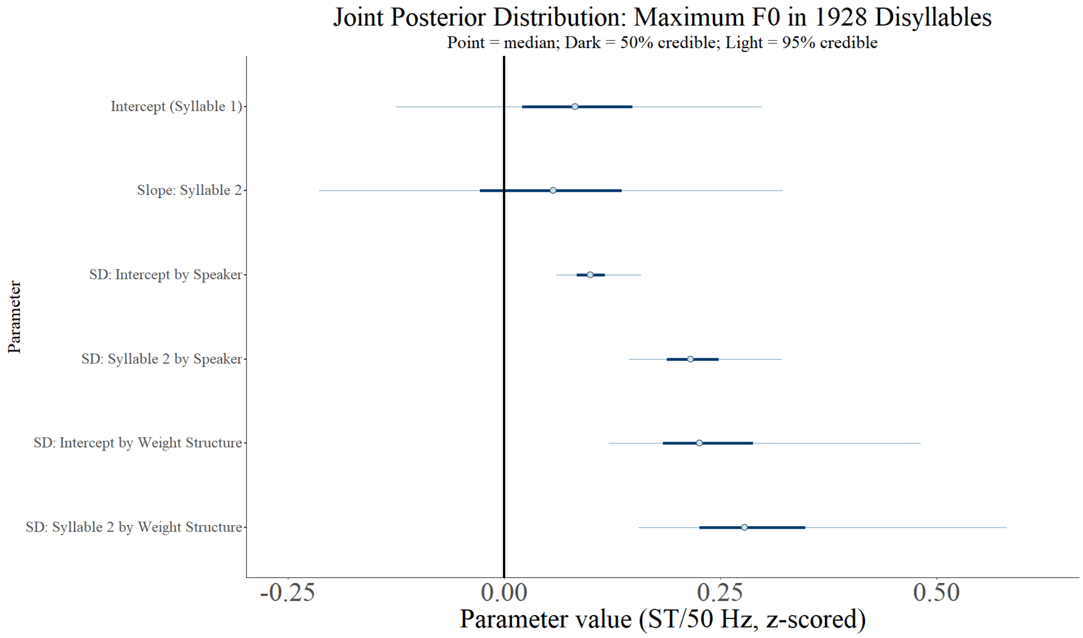
Model 4, 2020-21 Trisyllables (pp.129-130):



Pages 129-130: *Joint posterior distribution for Model 4 (maximum intensity in 2020-21 trisyllables).*

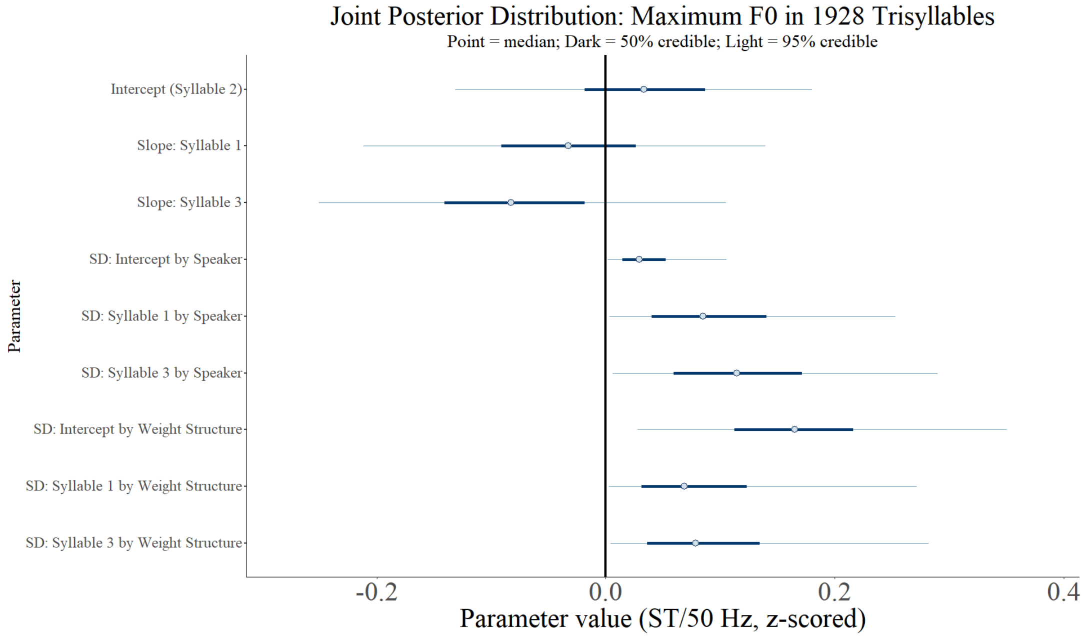
Models 5-8, Maximum F0 (Section 5.2.2):

Model 5, 1928 Disyllables (pp.134-135):



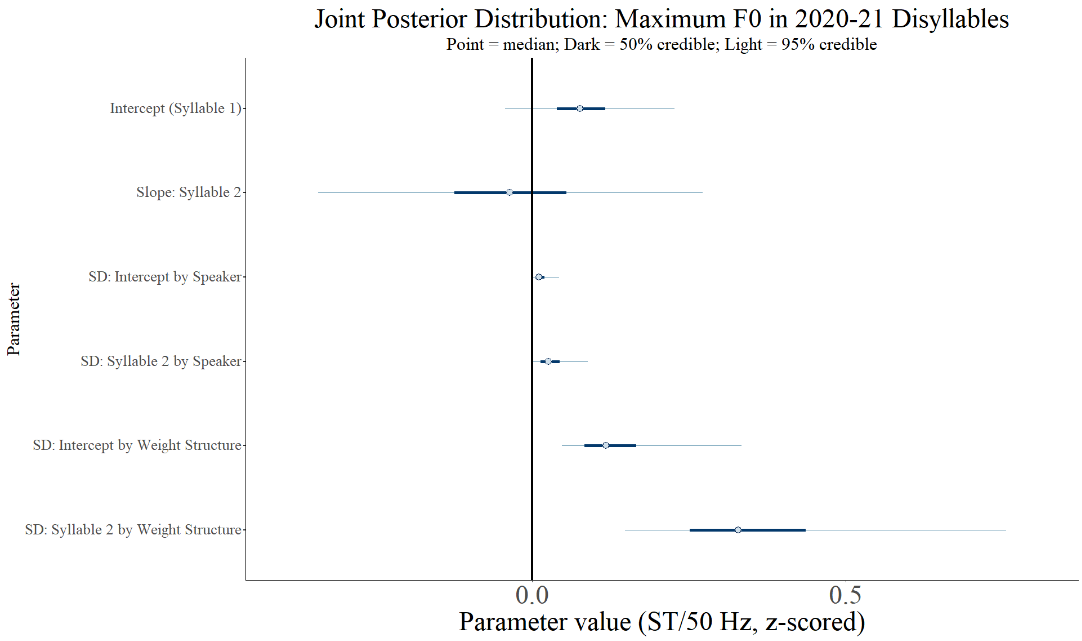
Pages 134-135: *Joint posterior distribution for Model 5 (maximum F0 in 1928 disyllables).*

Model 6, 1928 Trisyllables (pp.138-139):



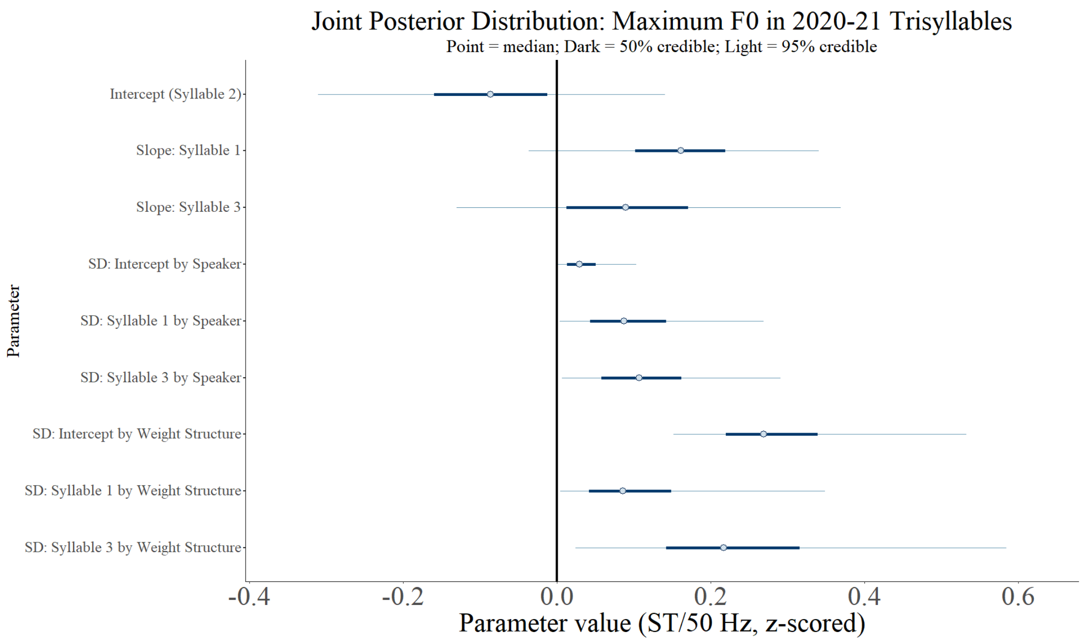
Pages 138-139: *Joint posterior distribution for Model 6 (maximum F0 in 1928 trisyllables).*

Model 7, 2020-21 Disyllables (pp.140-141):



Pages 140-141: *Joint posterior distribution for Model 6 (maximum F0 in 2020-21 disyllables).*

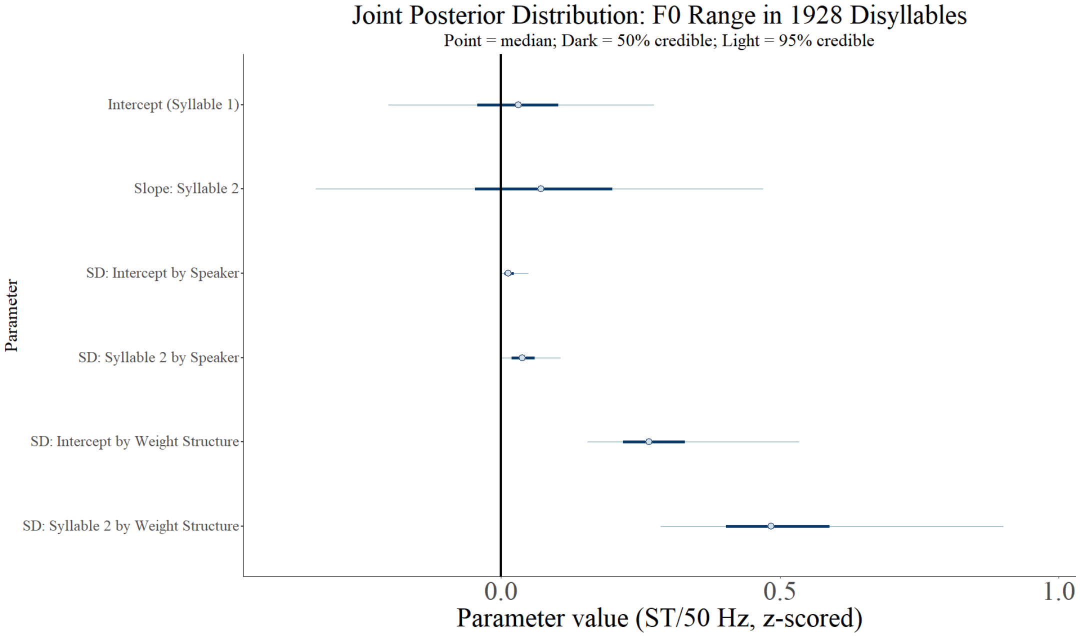
Model 8, 2020-21 Trisyllables (pp.143-144):



Pages 143-144: *Joint posterior distribution for Model 7 (maximum F0 in 2020-21 trisyllables).*

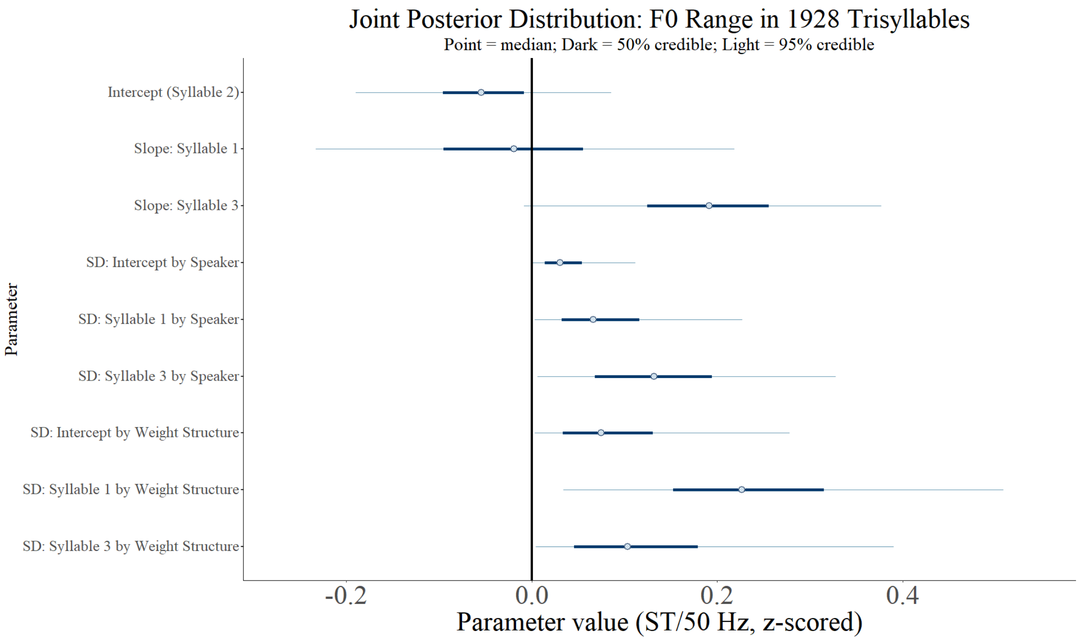
Models 9-12, F0 Range (Section 5.2.3):

Model 9, 1928 Disyllables (pp.147-148):



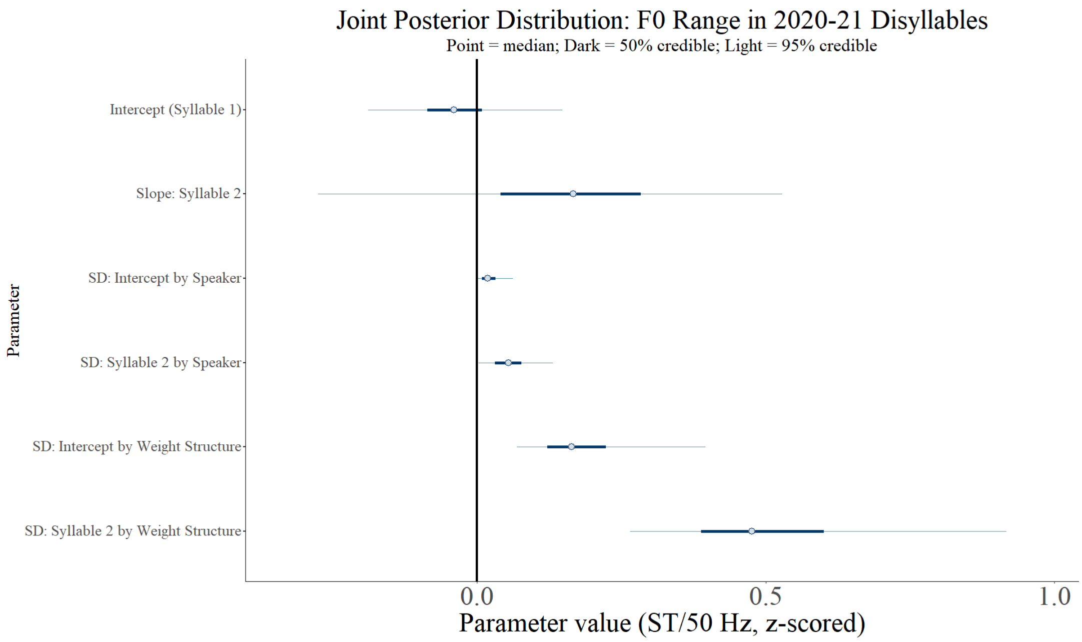
Pages 147-148: *Joint posterior distribution for Model 9 (F0 range in 1928 disyllables).*

Model 10, 1928 Trisyllables (pp.149-150):



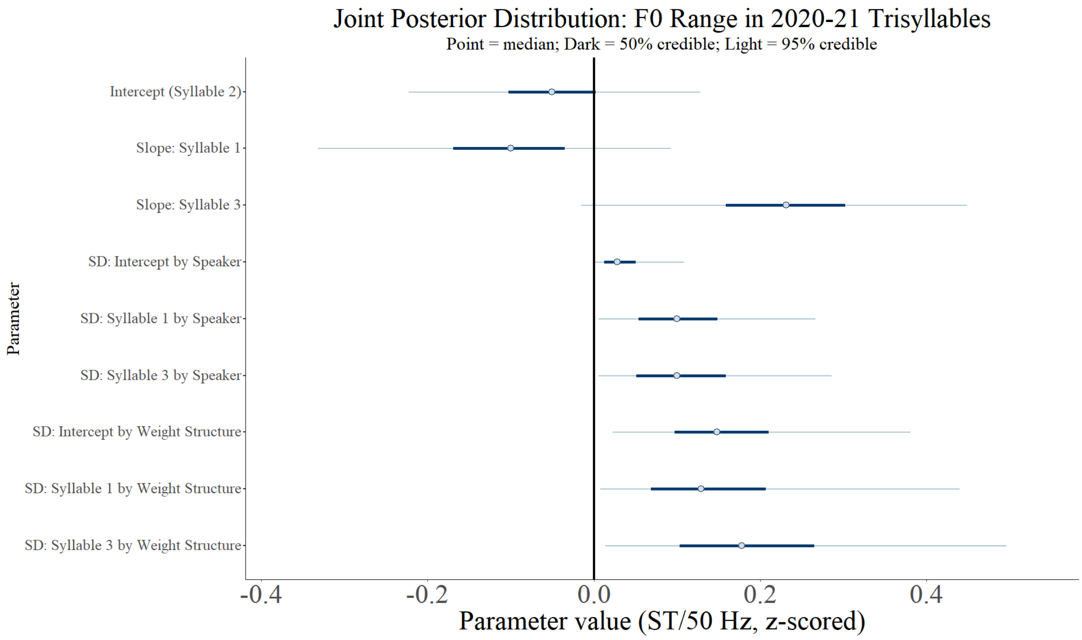
Pages 149-150: *Joint posterior distribution for Model 10 (F0 range in 1928 trisyllables).*

Model 11, 2020-21 Disyllables (pp.151-152):



Pages 151-152: *Joint posterior distribution for Model 11 (F0 range in 2020-21 disyllables).*

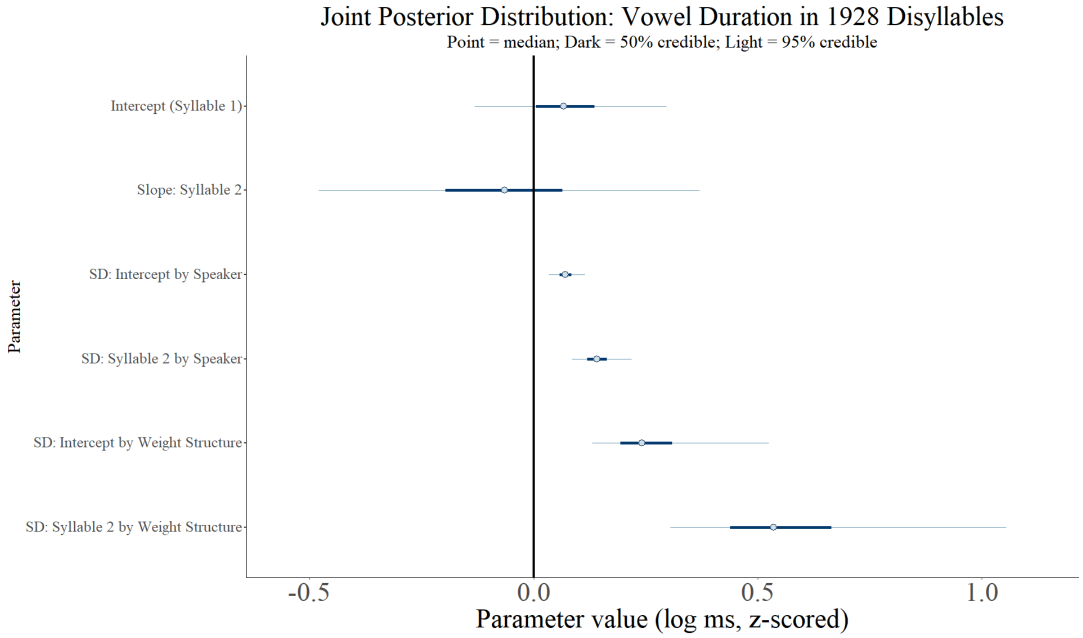
Model 12, 2020-21 Trisyllables (pp.152-153):



Pages 152-153: *Joint posterior distribution for Model 12 (F0 range in 2020-21 trisyllables).*

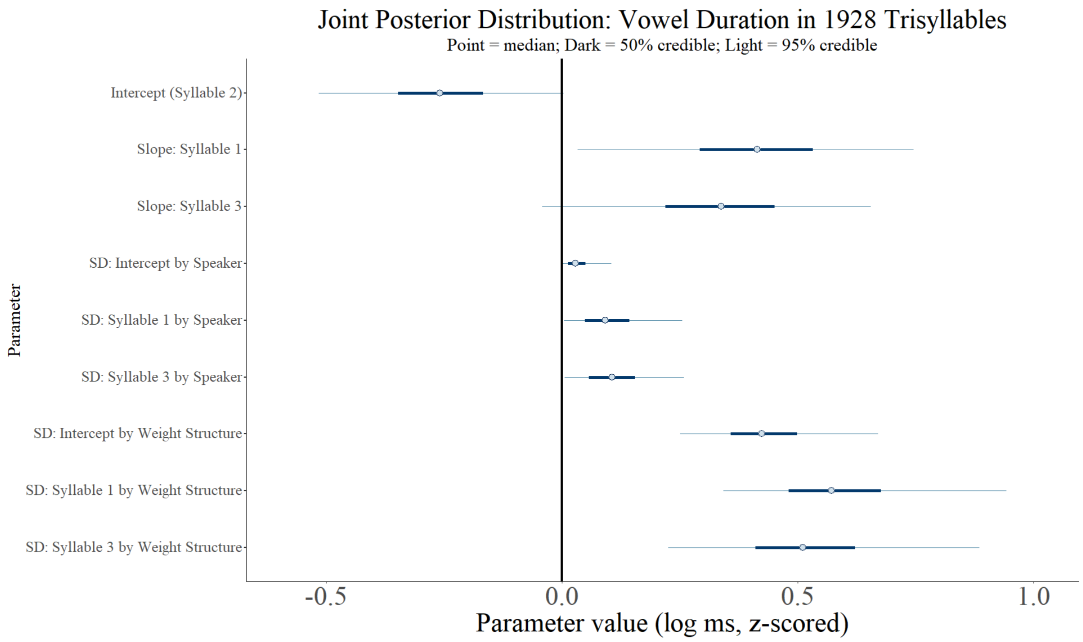
Models 13-16, Vowel duration (Section 5.2.4):

Model 13, 1928 Disyllables (pp.156-157):



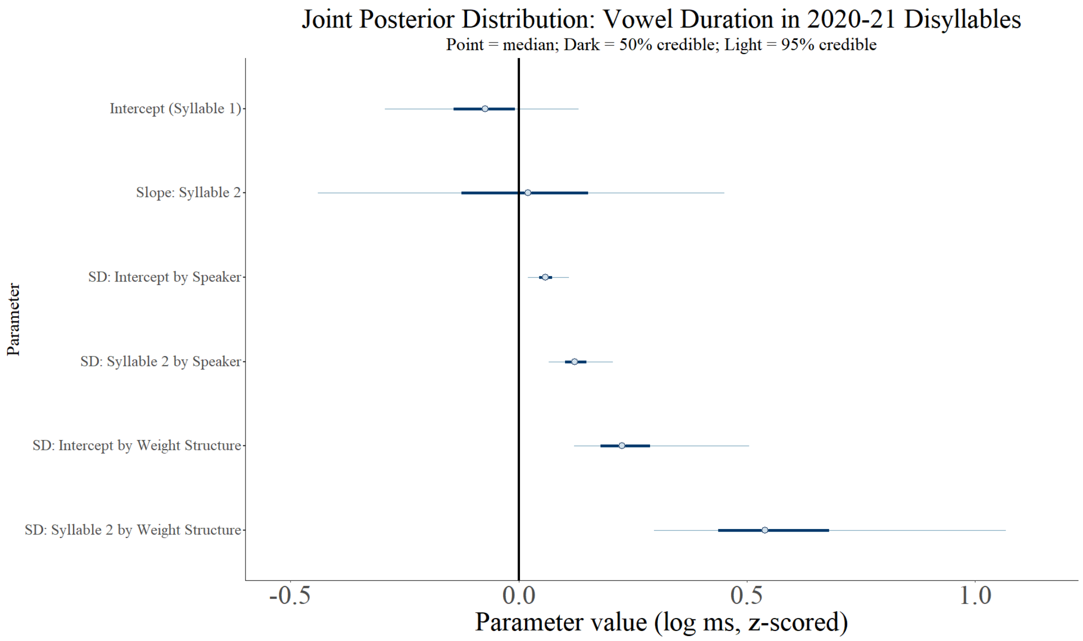
Pages 156-157: *Joint posterior distribution for Model 13 (vowel duration in 1928 disyllables).*

Model 13, 1928 Trisyllables (pp.159-160):



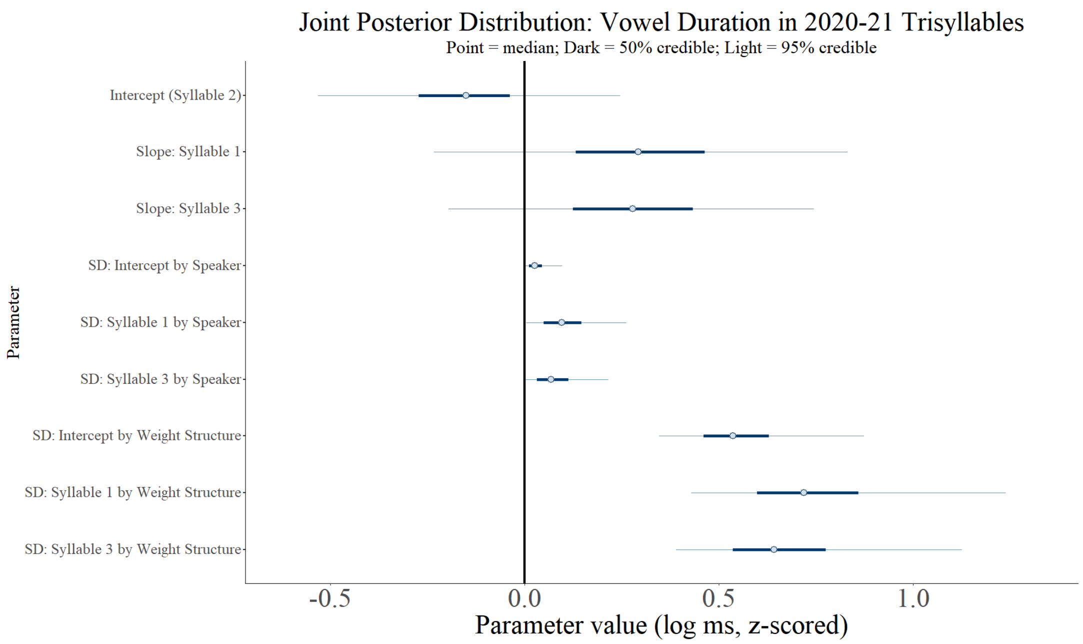
Pages 159-160: *Joint posterior distribution for Model 14 (vowel duration in 1928 trisyllables).*

Model 15, 2020-21 Disyllables (pp.160-161):



Pages 160-161: *Joint posterior distribution for Model 15 (vowel duration in 2020-21 disyllables).*

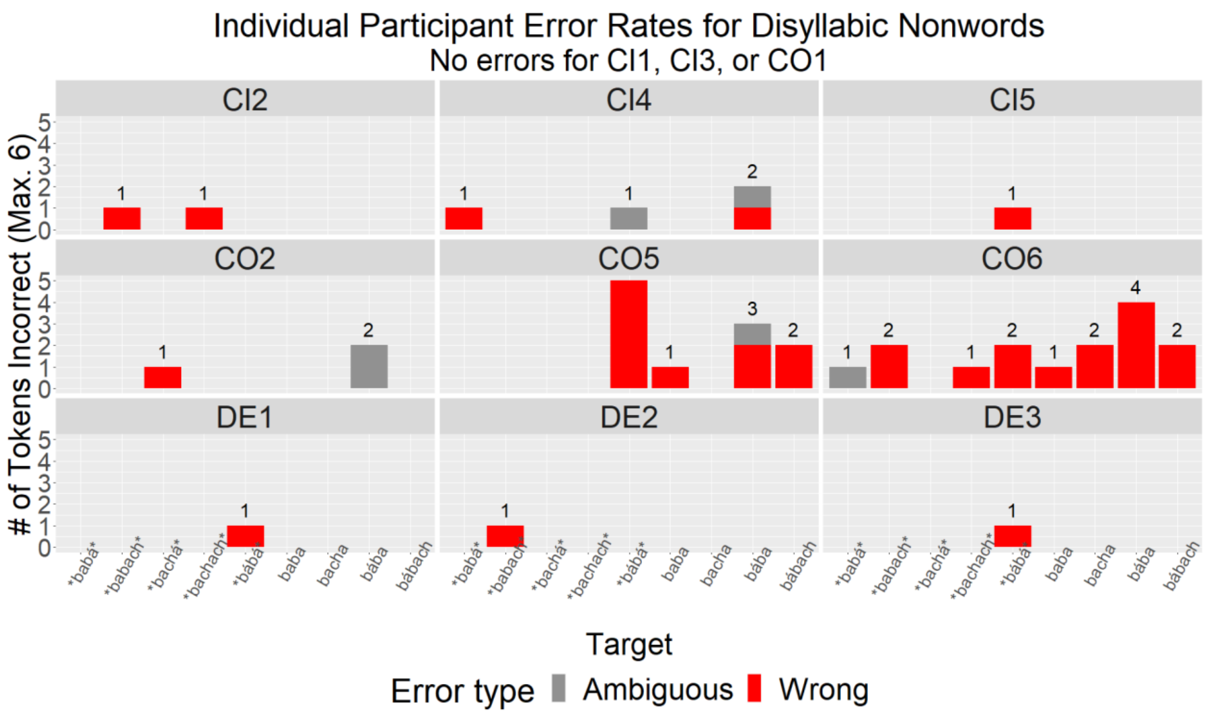
Model 16, 2020-21 Trisyllables (pp.163-164):



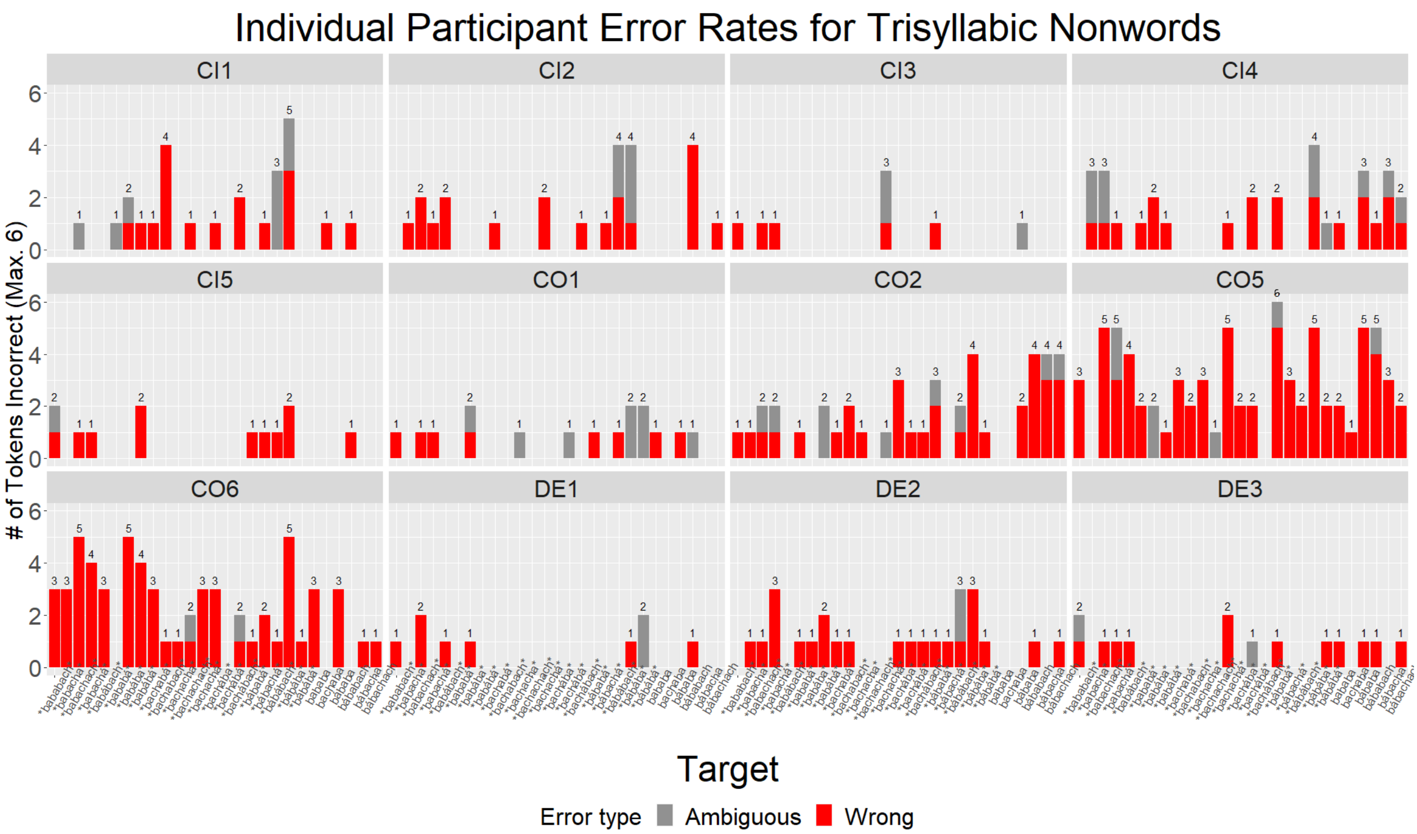
Pages 163-164: *Joint posterior distribution for Model 16 (vowel duration in 2020-21 trisyllables).*

Appendix C: Supplemental materials for Chapter 6

Individual-participant error rates (p.175):



Page 175: *Error rates across individual participants for production of disyllabic nonwords. Participants CI1, CI3, and CO1 had no errors at all for the disyllabic targets.*



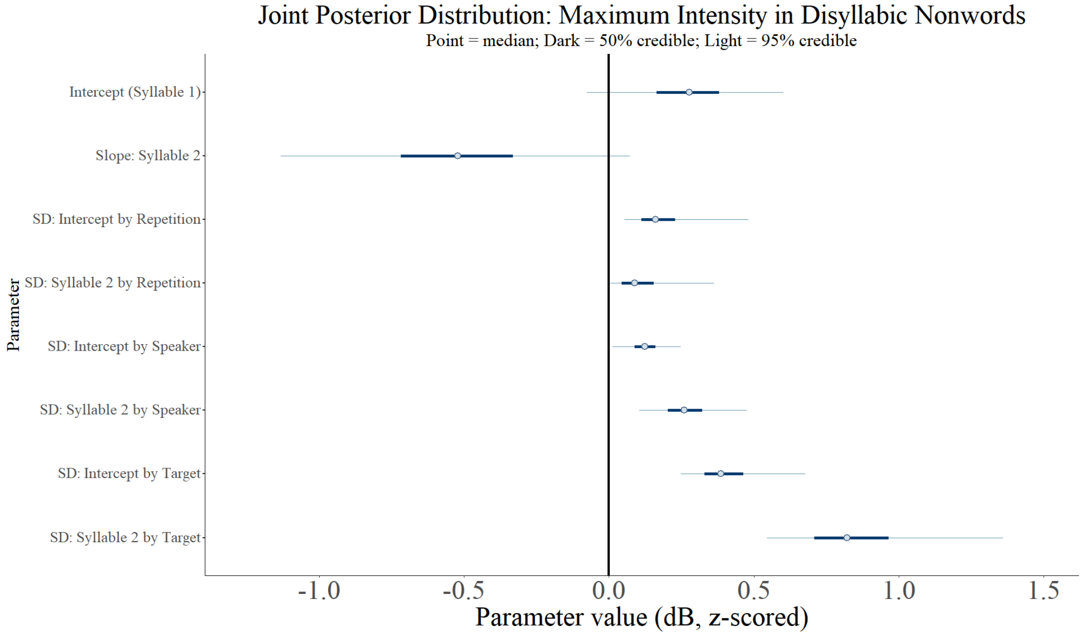
Page 175: *Error rates across individual participants for production of trisyllabic nonwords.*

All disyllable models: MEASURE ~ Second syllable + (Second syllable | Speaker) + (Second syllable | Weight structure) + (Second syllable | Repetition)

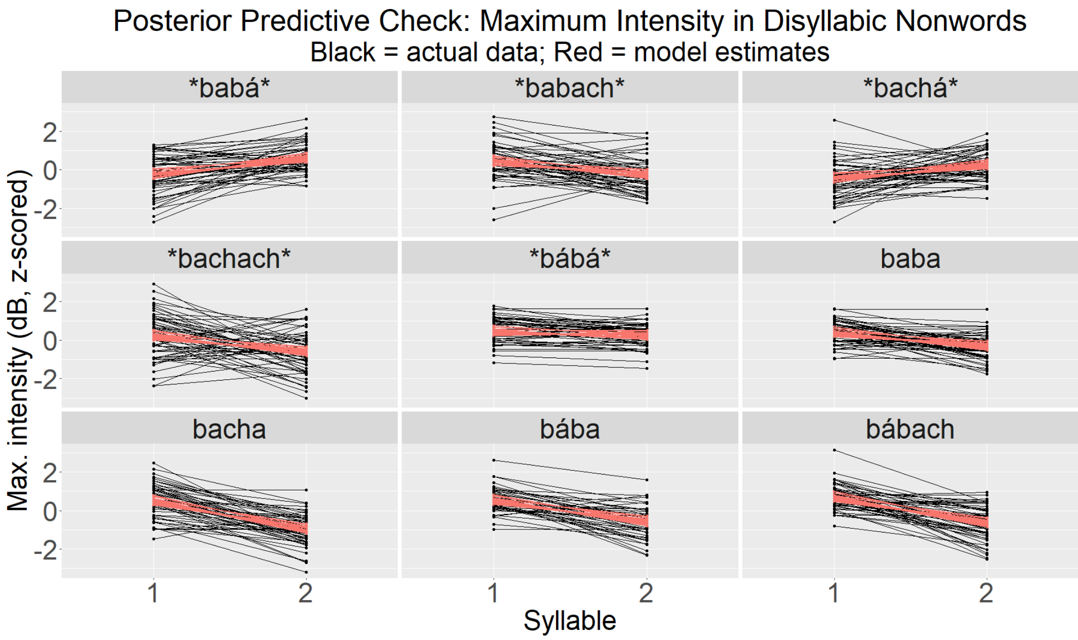
All trisyllable models: MEASURE ~ First syllable + Third syllable + (Both | Speaker) + (Both | Weight structure) + (Both | Repetition)

Models 17-18, Maximum intensity (Section 6.3.1):

Model 17, Disyllables (pp.177-178):

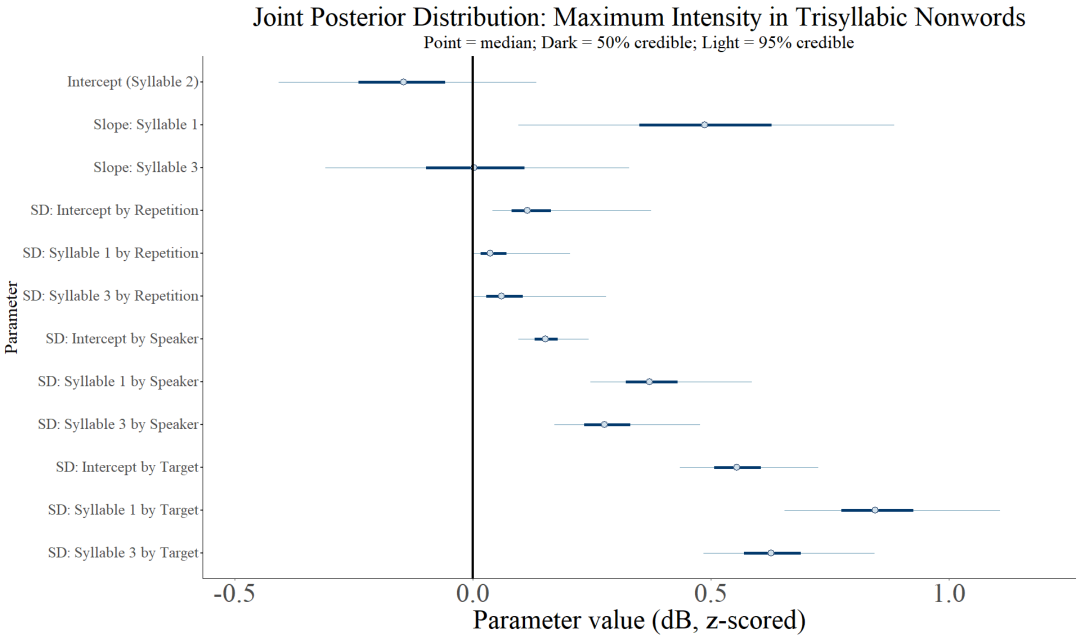


Pages 177-178: *Joint posterior distribution for Model 17 (maximum intensity in disyllabic nonwords).*

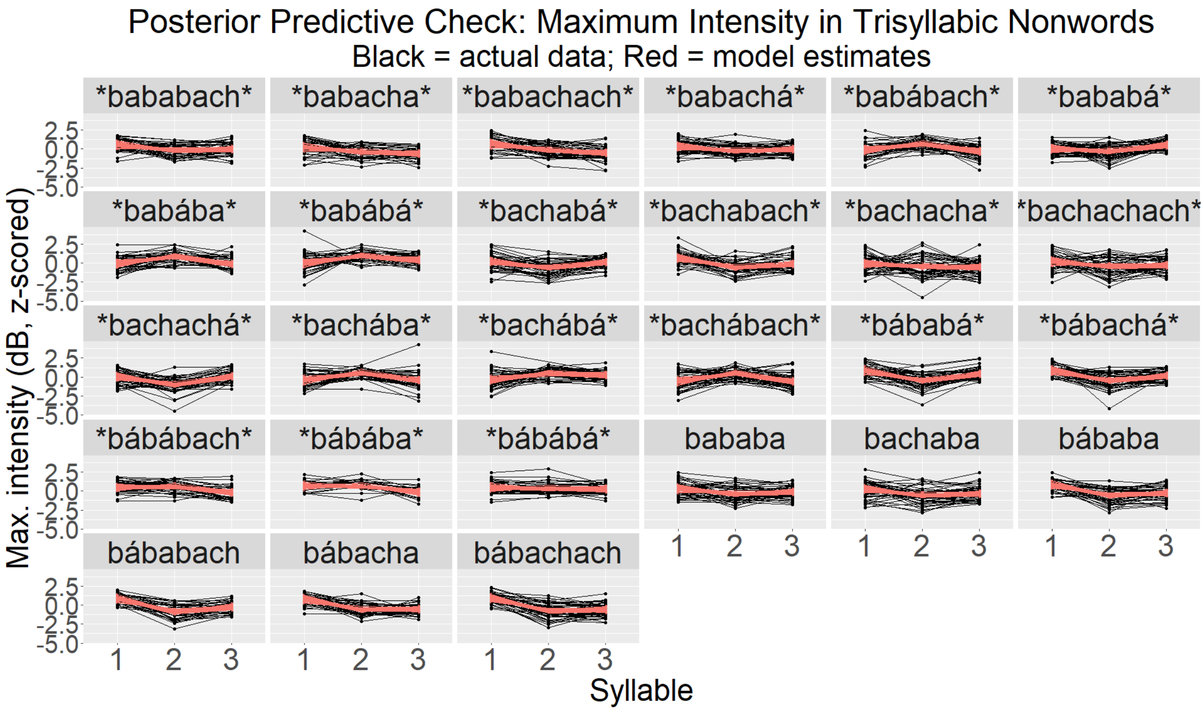


Pages 177-178: *Posterior predictive check for Model 17 (maximum intensity in disyllabic nonwords).*

Model 18, Trisyllables (pp.180-181):



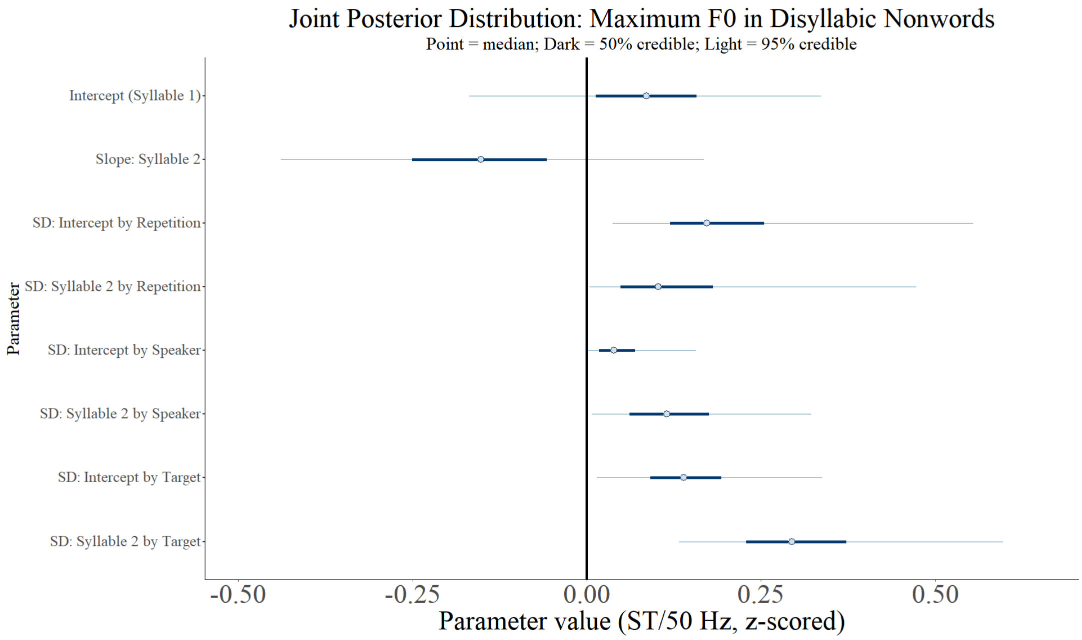
Pages 180-181: *Joint posterior distribution for Model 18 (maximum intensity in trisyllabic nonwords).*



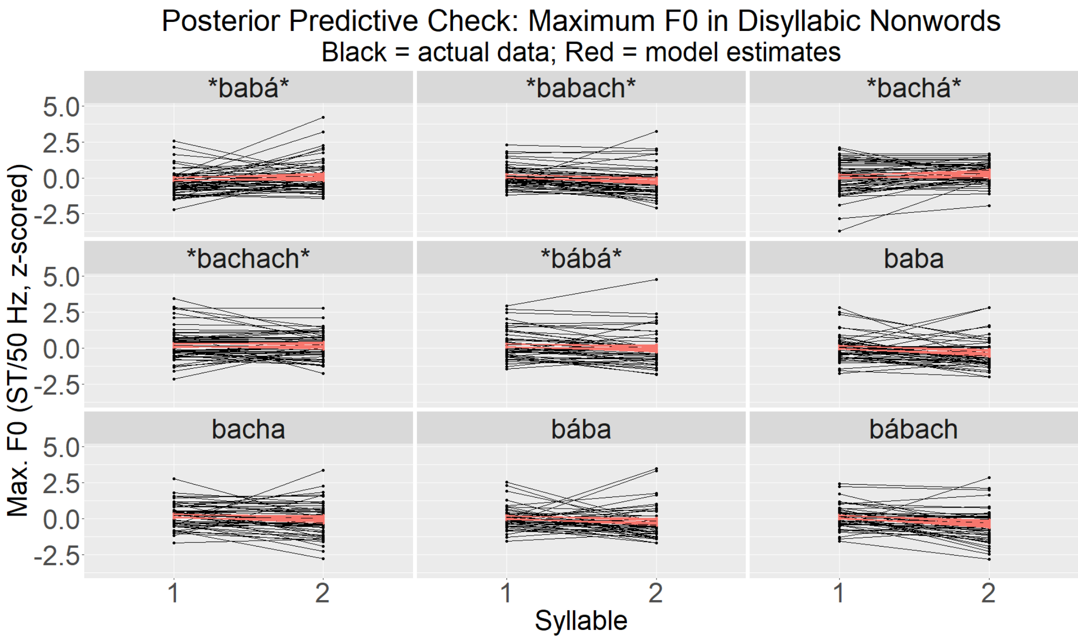
Pages 180-181: *Posterior predictive check for Model 17 (maximum intensity in trisyllabic nonwords).*

Models 19-20, Maximum F0 (Section 6.3.2):

Model 19, Disyllables (pp.182-183):

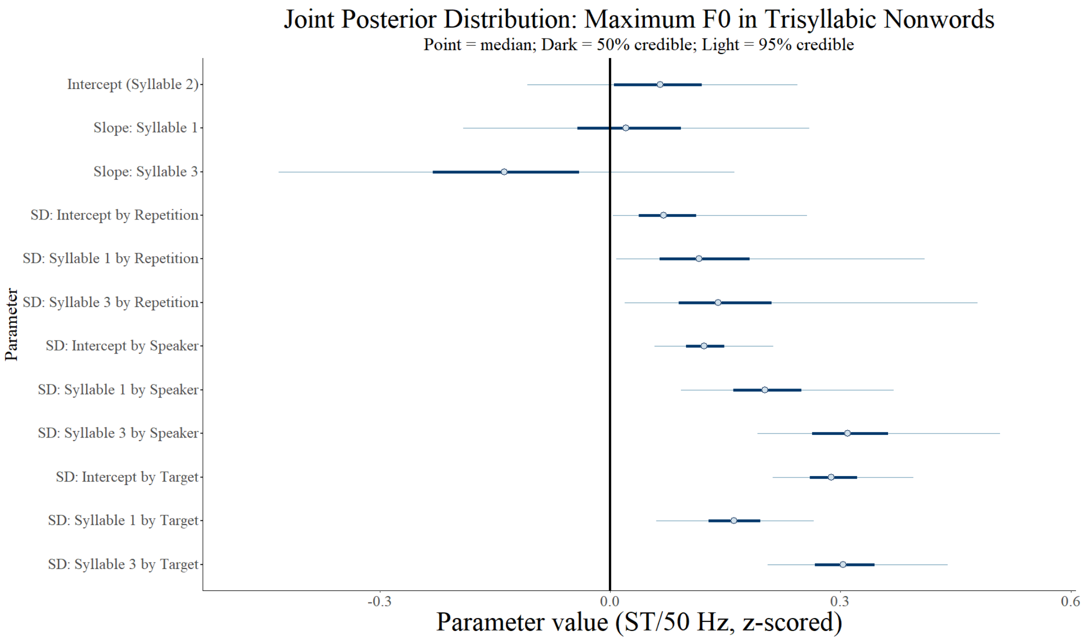


Pages 182-183: *Joint posterior distribution for Model 19 (maximum F0 in disyllabic nonwords).*

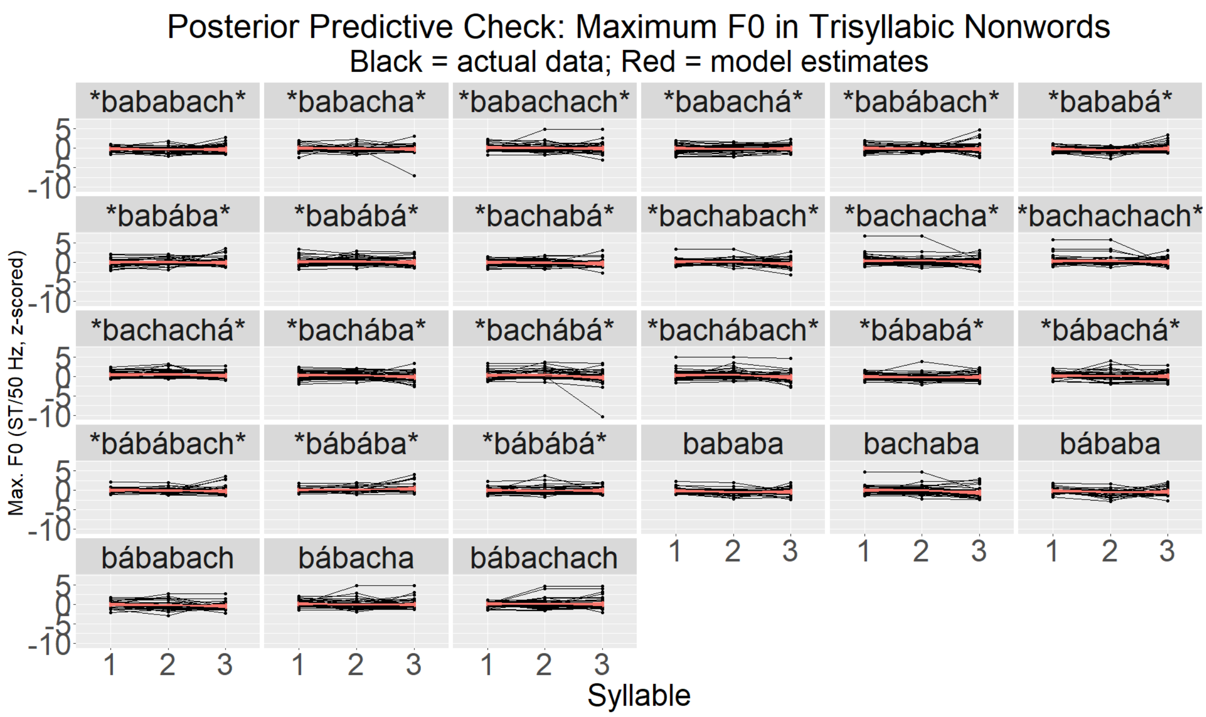


Pages 182-183: *Posterior predictive check for Model 19 (maximum intensity in disyllabic nonwords).*

Model 20, Trisyllables (p.184):



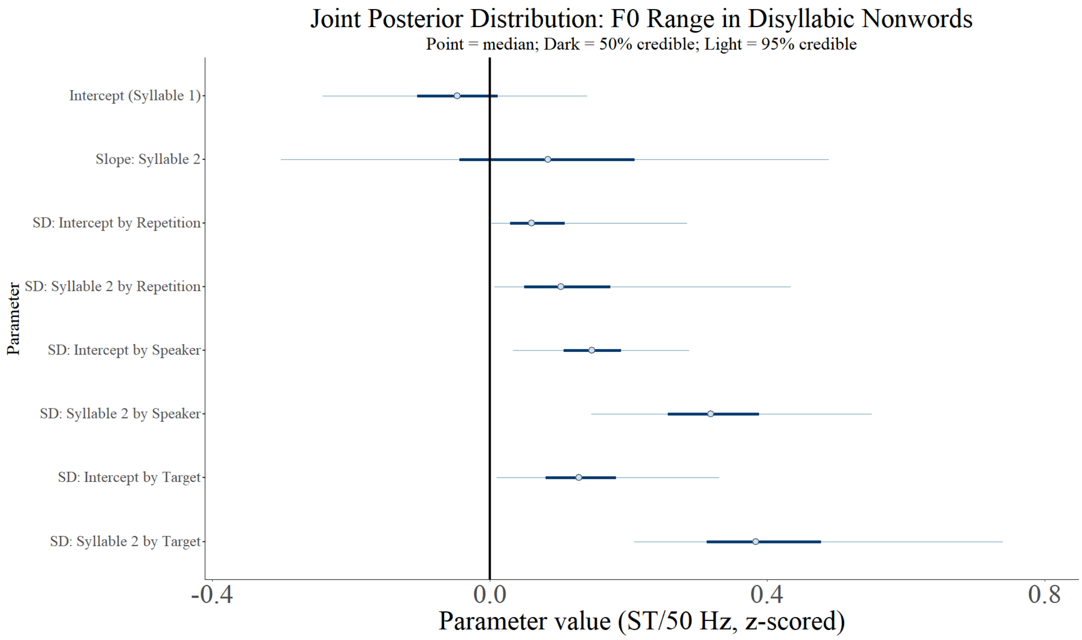
Page 184: *Joint posterior distribution for Model 20 (maximum F0 in trisyllabic nonwords).*



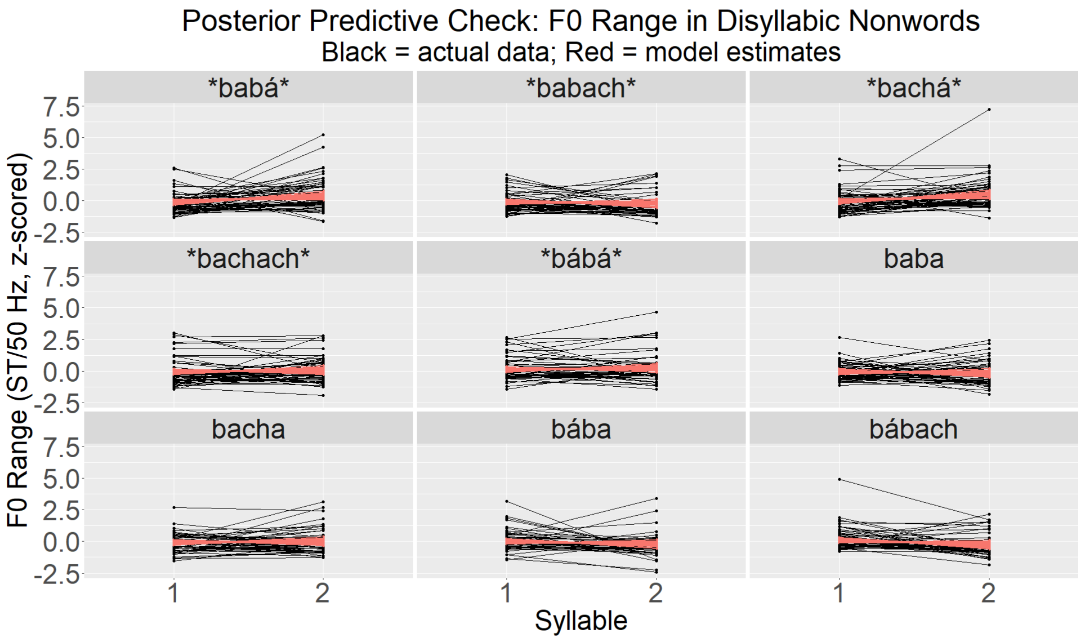
Page 184: *Posterior predictive check for Model 17 (maximum F0 in trisyllabic nonwords).*

Models 21-22, F0 Range (Section 6.3.3):

Model 21, Disyllables (pp.186-187):

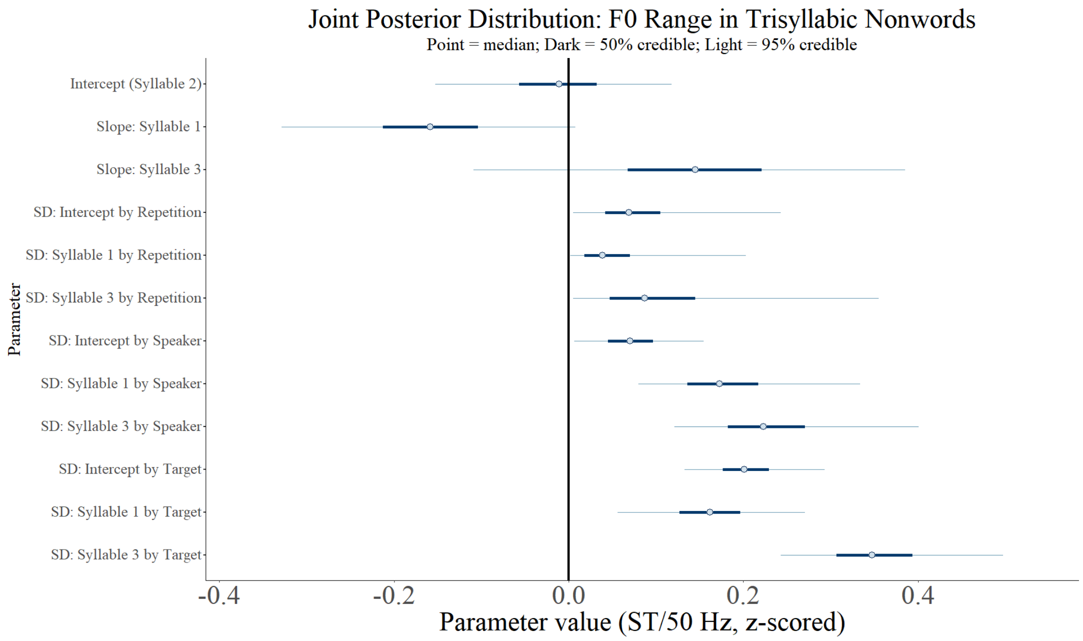


Pages 186-187: *Joint posterior distribution for Model 21 (F0 range in disyllabic nonwords).*

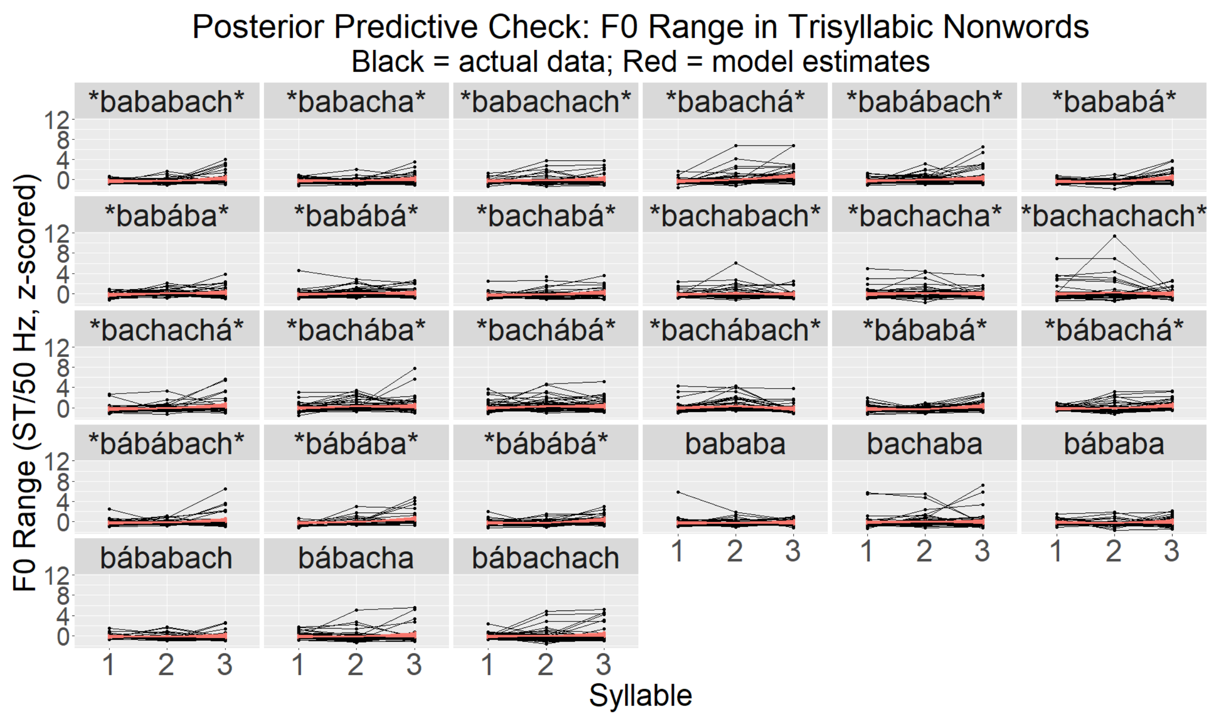


Pages 186-187: *Posterior predictive check for Model 21 (F0 range in disyllabic nonwords).*

Model 22, Trisyllables (pp.187-188):



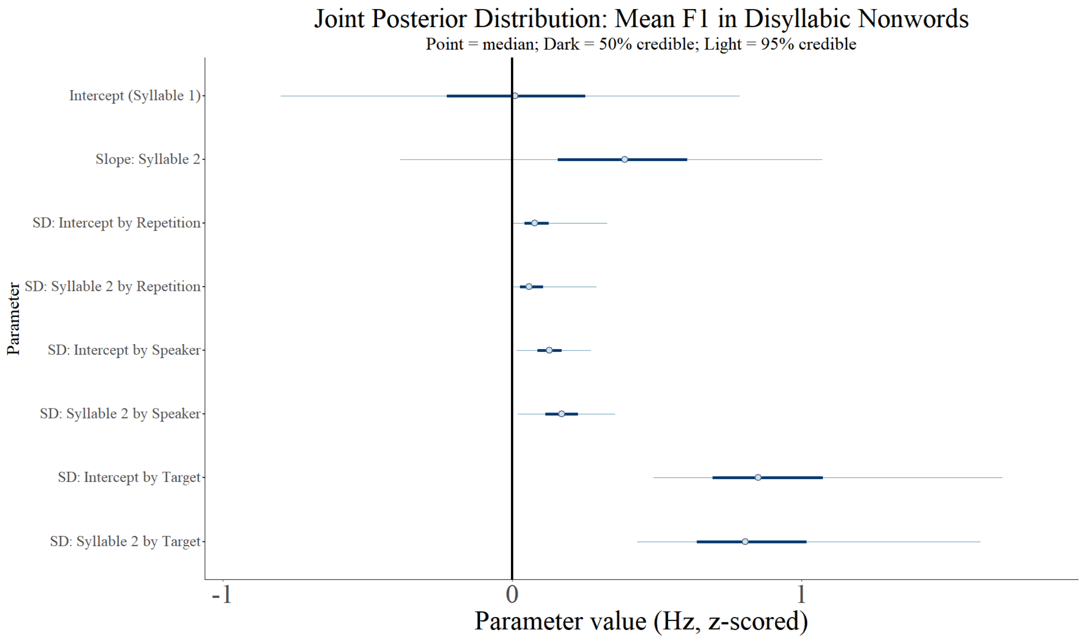
Pages 187-188: *Joint posterior distribution for Model 22 (F0 range in disyllabic nonwords).*



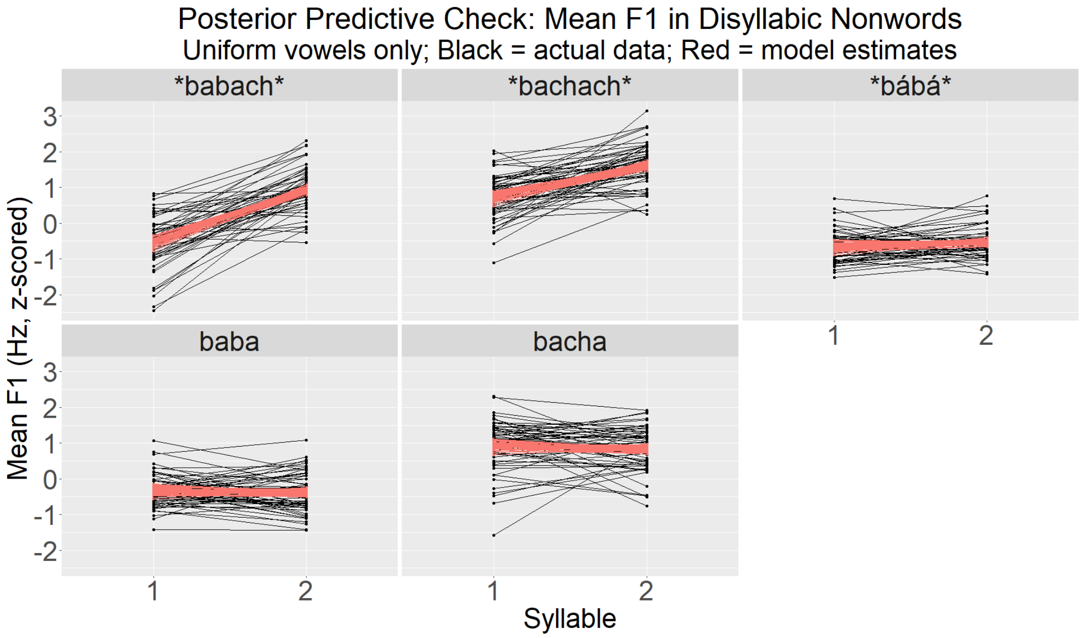
Pages 187-188: *Posterior predictive check for Model 22 (F0 range in trisyllabic nonwords).*

Models 23-24, Mean F1 (Section 6.3.4):

Model 23, Disyllables (pp.189-190):

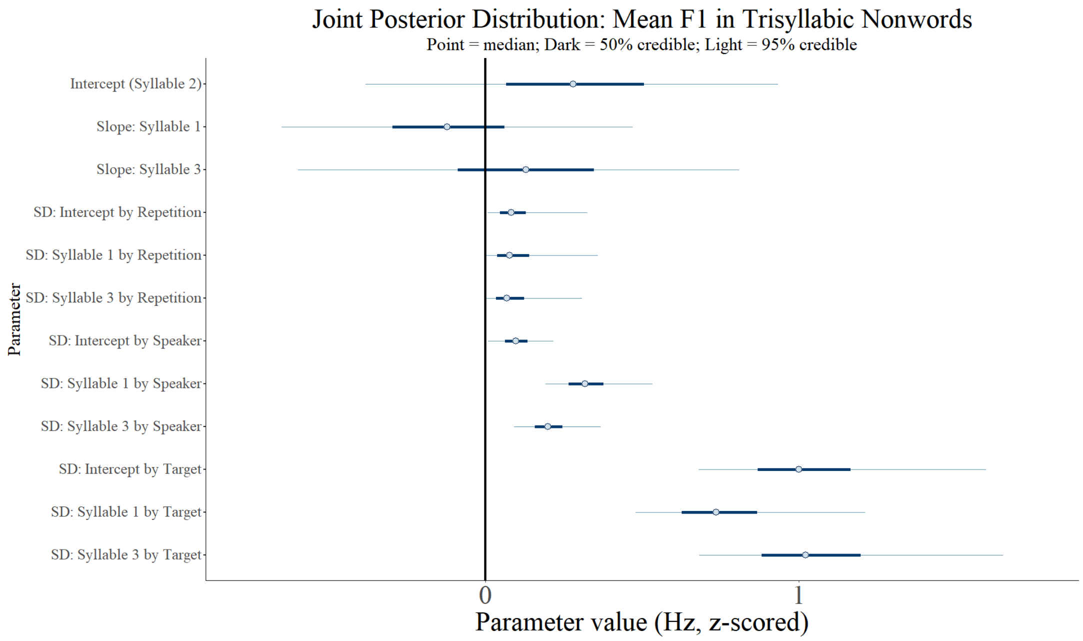


Pages 189-190: *Joint posterior distribution for Model 23 (mean F1 in disyllabic nonwords with uniform vowels).*

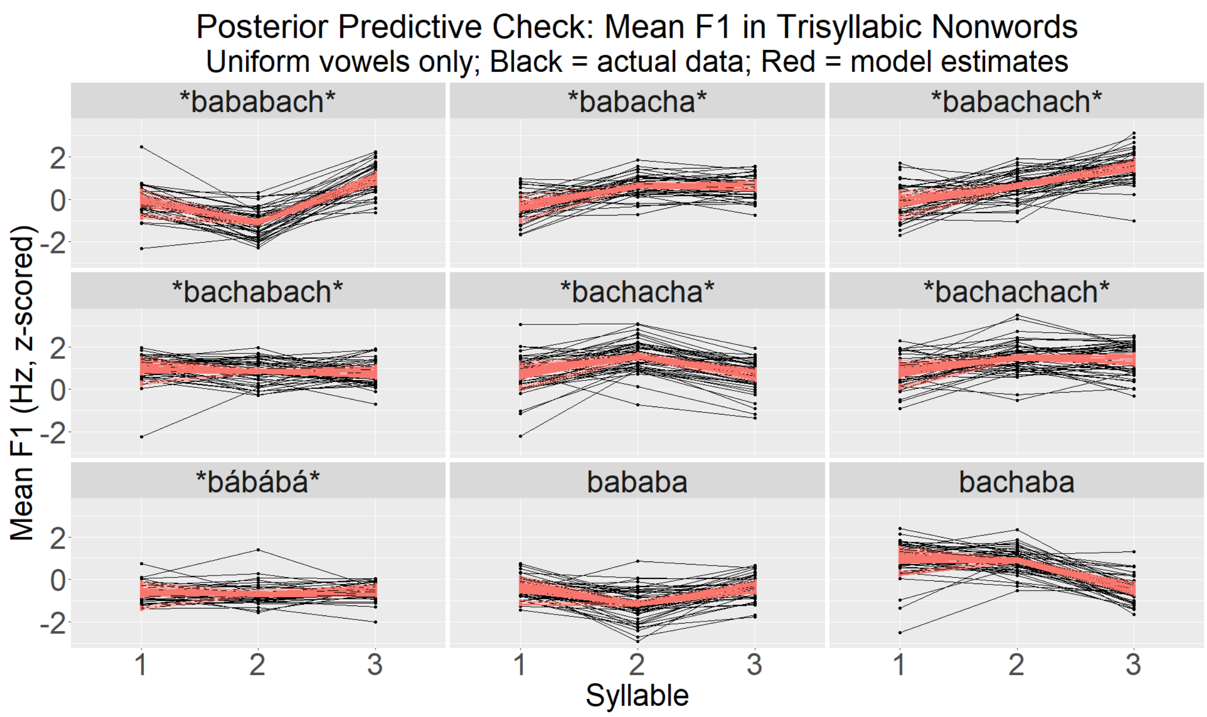


Pages 189-190: *Posterior predictive check for Model 23 (mean F1 in disyllabic nonwords with uniform vowels).*

Model 24, Trisyllables (pp.191-192):



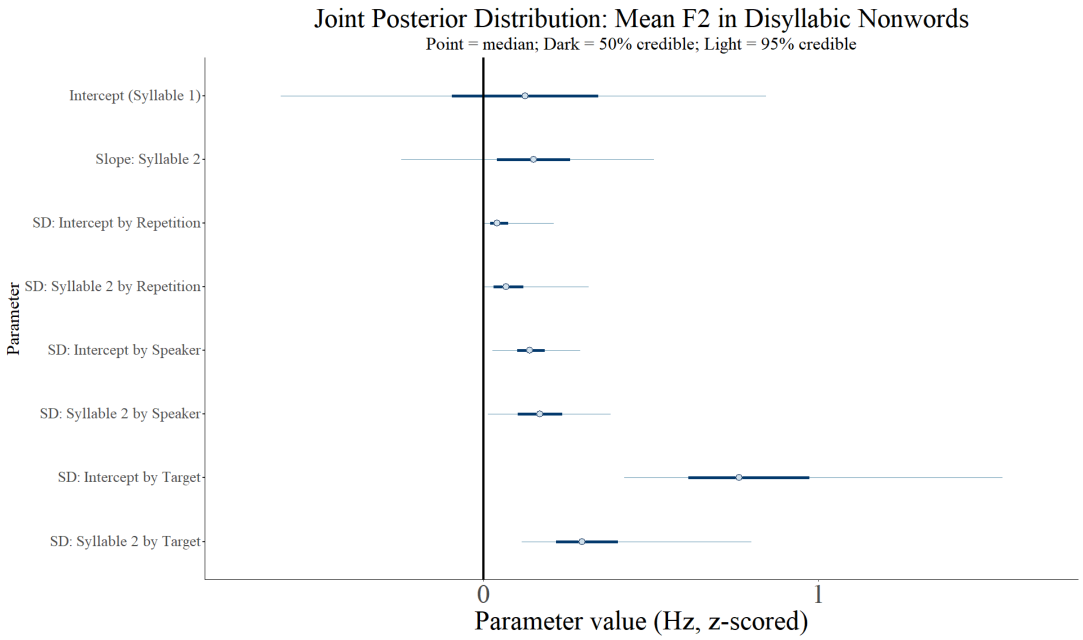
Pages 191-192: *Joint posterior distribution for Model 24 (mean F1 in disyllabic nonwords with uniform vowels).*



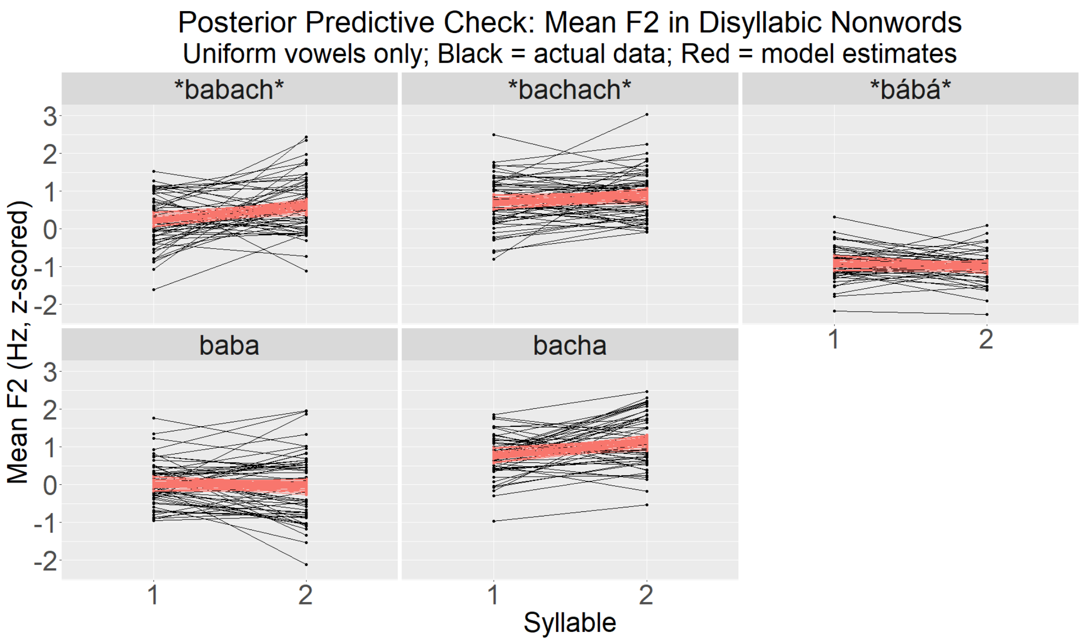
Pages 191-192: *Posterior predictive check for Model 24 (mean F1 in trisyllabic nonwords with uniform vowels).*

Models 25-26, Mean F2 (Section 6.3.5):

Model 25, Disyllables (pp.194-195):

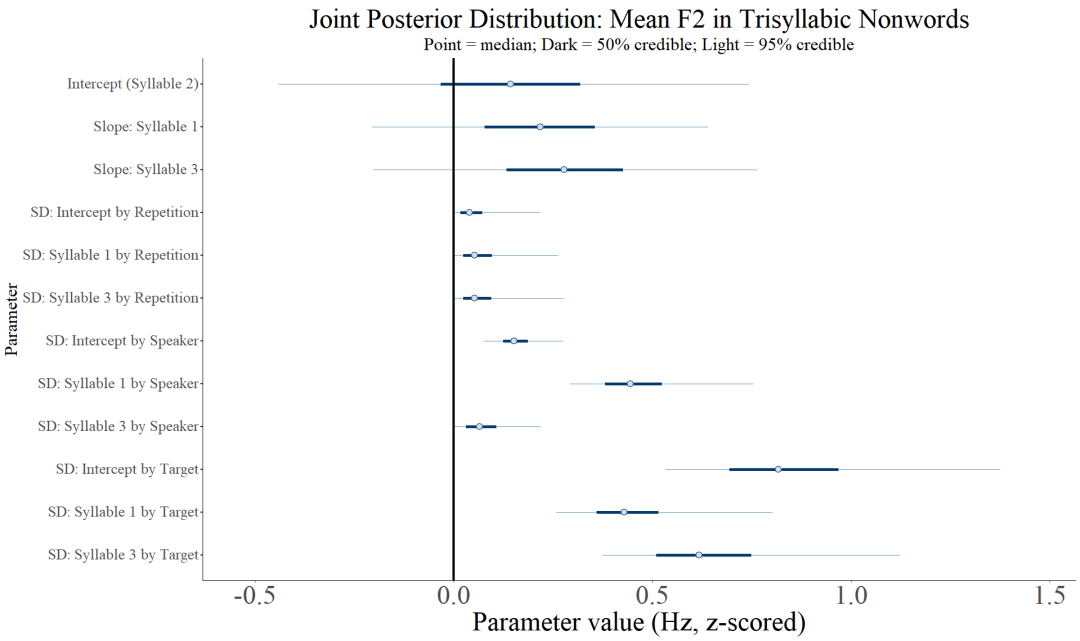


Pages 194-195: *Joint posterior distribution for Model 25 (mean F2 in disyllabic nonwords with uniform vowels).*

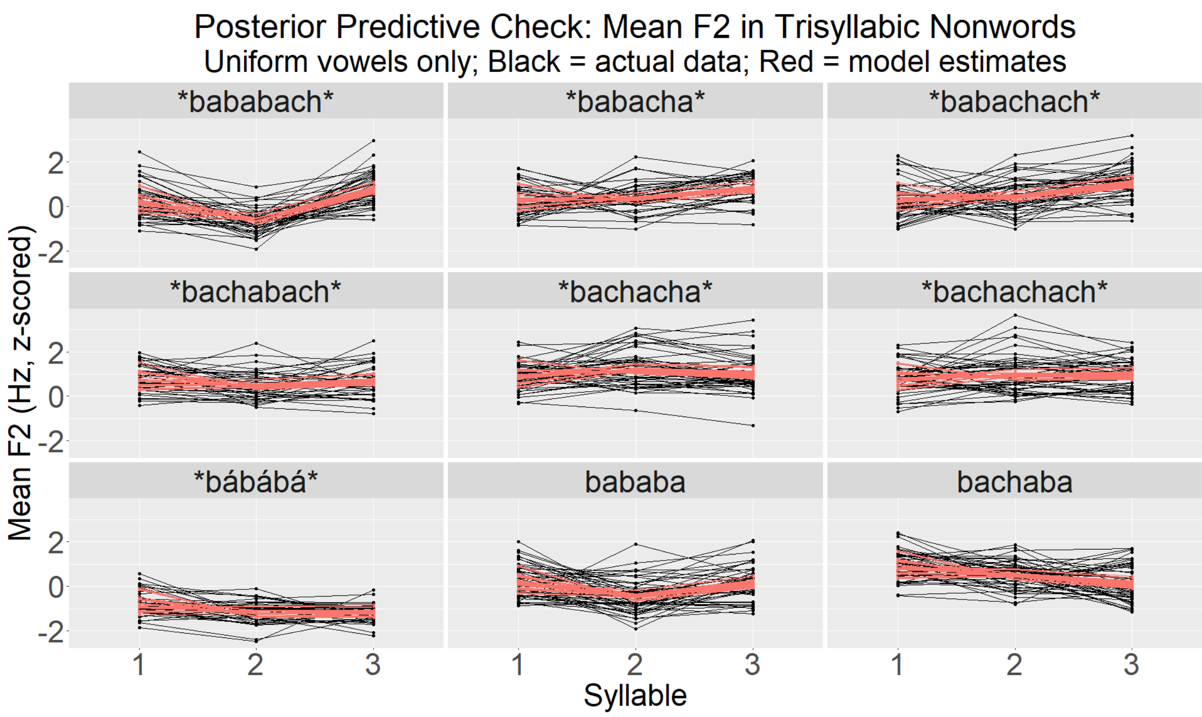


Pages 194-195: *Posterior predictive check for Model 25 (mean F2 in disyllabic nonwords with uniform vowels).*

Model 26, Trisyllables (pp.195-196):



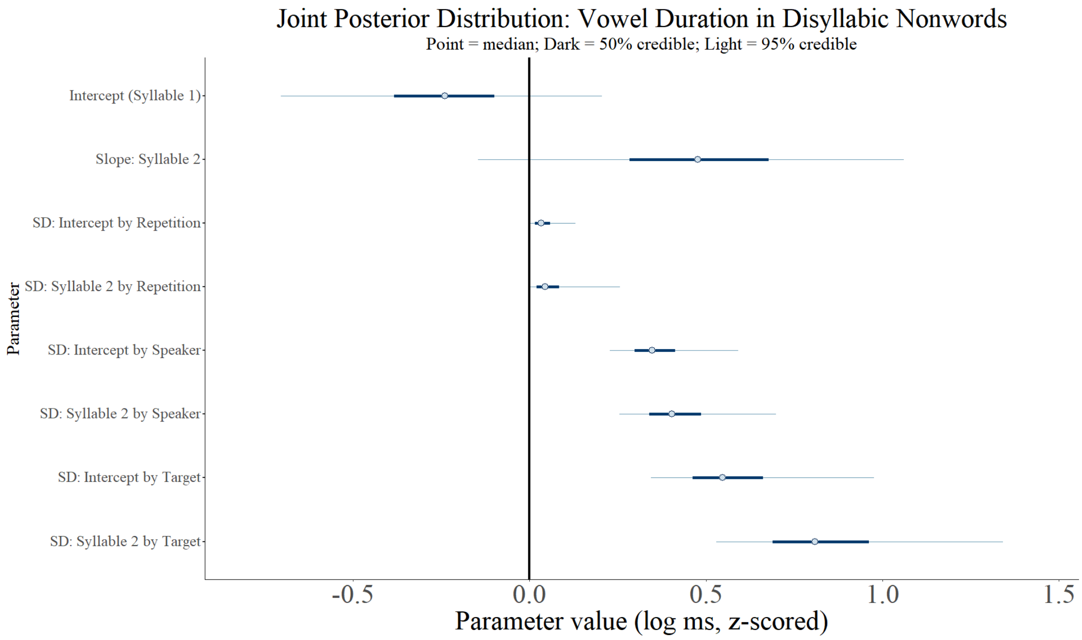
Pages 195-196: *Joint posterior distribution for Model 26 (mean F2 in trisyllabic nonwords with uniform vowels).*



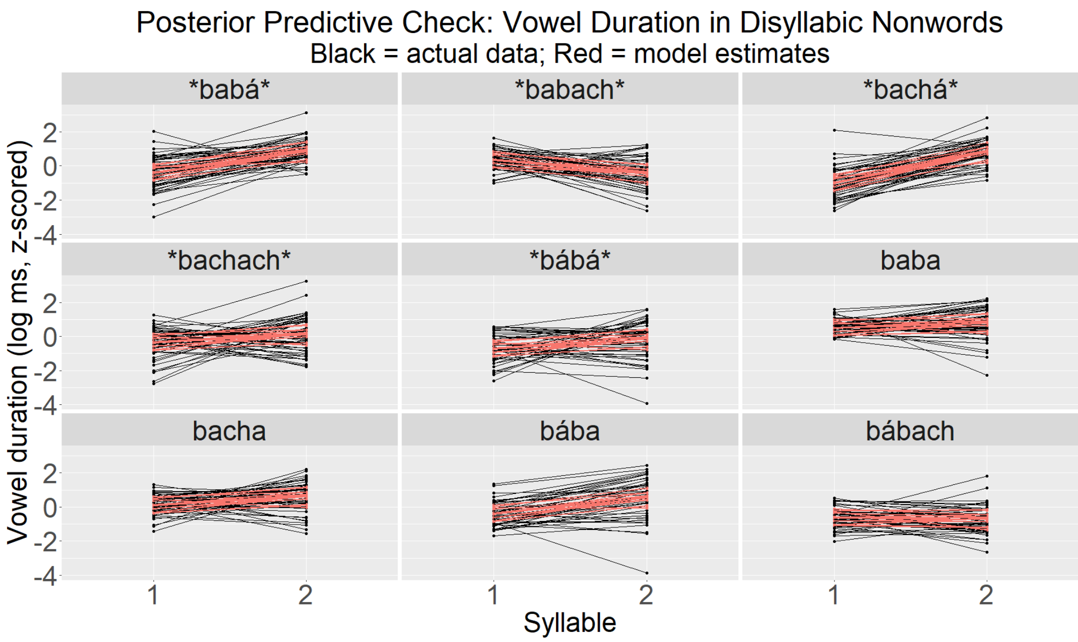
Pages 195-196: *Posterior predictive check for Model 26 (mean F2 in trisyllabic nonwords with uniform vowels).*

Models 27-28, Vowel Duration (Section 6.3.6):

Model 27, Disyllables (pp.198-199):

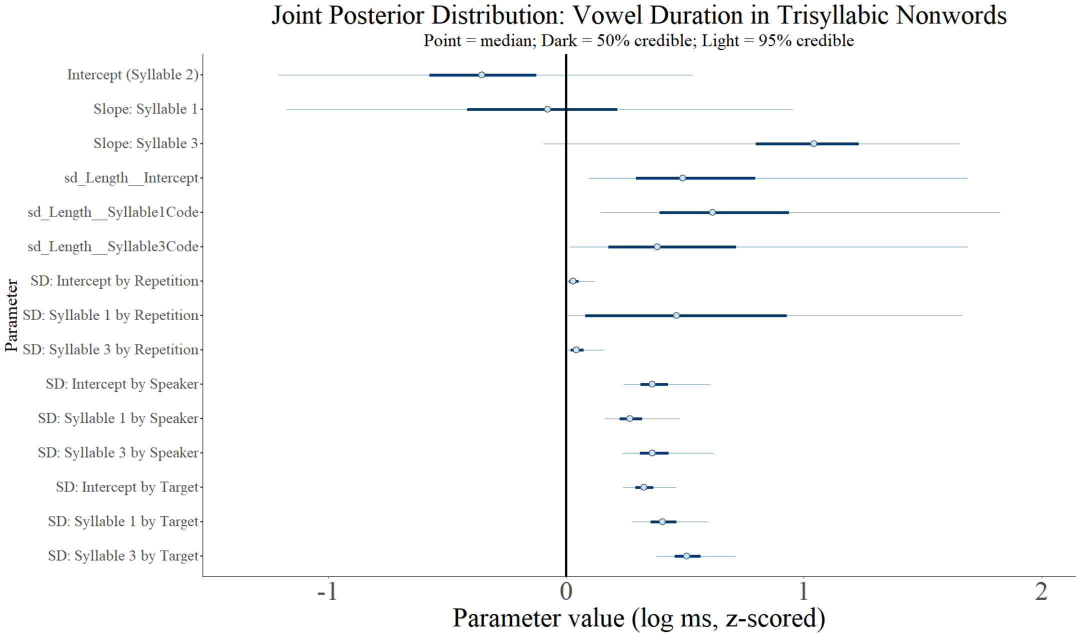


Pages 198-199: *Joint posterior distribution for Model 27 (vowel duration in disyllabic nonwords).*

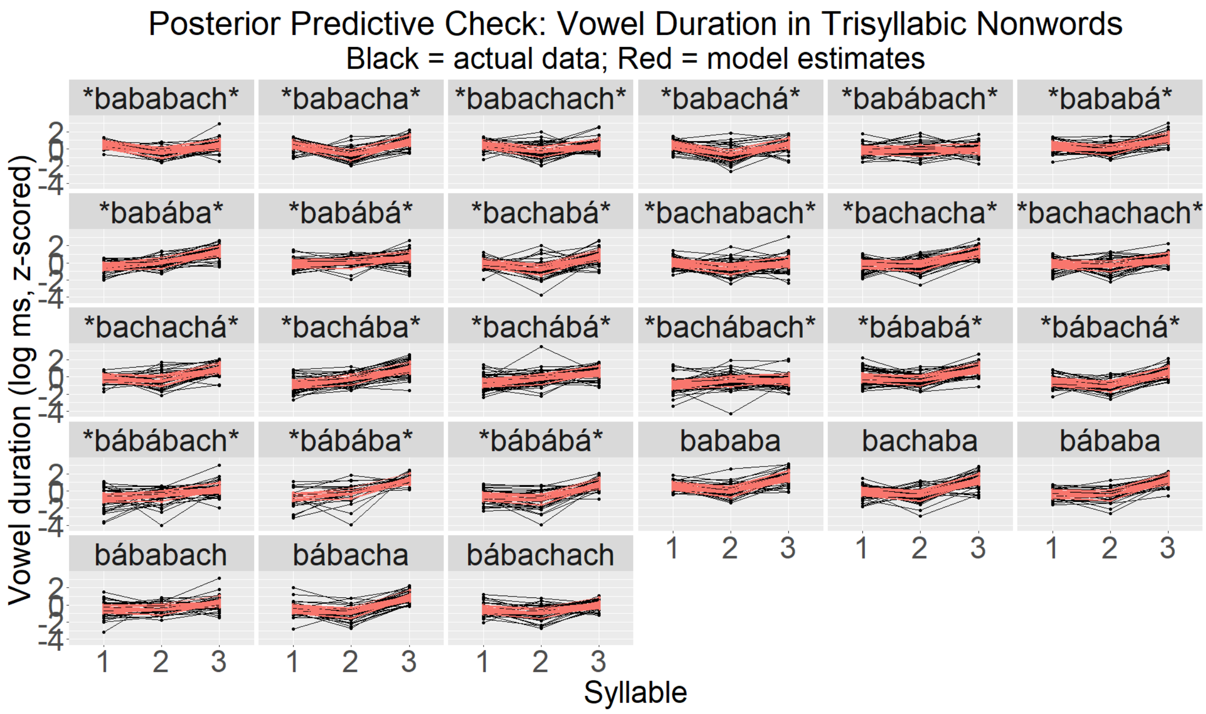


Pages 198-199: *Posterior predictive check for Model 27 (vowel duration in disyllabic nonwords).*

Model 28, Trisyllables (pp.199-200):



Pages 199-200: *Joint posterior distribution for Model 28 (vowel duration in trisyllabic nonwords).*



Pages 199-200: *Posterior predictive check for Model 28 (vowel duration in trisyllabic nonwords).*