Modularity and stratification in phonology: Evidence from Scottish Gaelic

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Contents

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Abstract

This thesis presents evidence from Scottish Gaelic for *modularity* and *stratification* in phonology. *Modularity* refers to the separation of the linguistic grammar into several components that each deal exclusively with a particular level of linguistic structure, such as morphosyntax, phonology and phonetics, and which communicate with one another in a tightly constrained manner. Strict versions of modularity face a challenge from widespread reports of direct lexical or morphological conditioning of gradient phonetic detail, which cannot be accounted for under the common assumption that the phonetics is sensitive only to the categorical output of the phonology. *Stratification* refers to the existence of different sets of phonological rules applying to different morphosyntactic domains, such as stems, words and entire utterances, which can account for opacity in morphologically derived forms. Specifically, I argue in favour of Stratal Optimality Theory, which is a stratified version of traditional Optimality Theory.

The thesis consists of four research papers which approach these theoretical questions from various angles. The first paper reports an acoustic study that explores the distinction between phonetic and phonological sound patterns by investigating inter-speaker variation in a number of allophonic oppositions in the vowel system of the dialect of Scottish Gaelic spoken in Ness, Lewis, some of which have never been reported before in the existing literature. It is found that these oppositions are categorical and phonological for some speakers, but gradient and phonetic for others.

The second paper reports a nasal airflow study in which both gradient phonetic and categorical phonological patterns of vowel nasalisation are found to occur in Scottish Gaelic. In accordance with the predictions of a strictly modular architecture, only phonological nasalisation is found to be sensitive to morphological conditioning, while phonetic nasalisation always applies transparently.

The third paper presents a detailed metrical analysis of the prosodic contrast between *Class 1* and *Class 2* forms in Scottish Gaelic, which are distinguished on the surface by either tonal accent, glottalisation or overlength depending on dialect. It is shown that Stratal Optimality Theory is capable of accounting for the complex patterns observed, including numerous opaque interactions between segmental and prosodic structure, in a principled manner.

Finally, the fourth paper presents a detailed analysis of the opposition between *broad* and *slender* vowels and consonants in Scottish Gaelic, showing that the broad or slender quality of a vowel is almost always derived phonologically from that of the adjacent consonants. Stratal Optimality Theory is shown to be capable of accounting for highly complex opaque interactions between the broad–slender opposition and various morphological processes.

These four papers together show that the Scottish Gaelic data are particularly amenable to analysis within a framework in which the grammar is modular and phonology is stratified. This thesis therefore demonstrates the degree to which the complex sound system of Scottish Gaelic can inform linguistic theory. It also provides vital documentation of an endangered language, and offers unprecedentedly thorough treatments of several aspects of Scottish Gaelic phonology.

Declaration

I declare that no portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

Copyright statement

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Alex M. Nicholson
Lionel

Chapter 1

Introduction

This thesis comprises a collection of four articles that investigate various aspects of the sound system of Scottish Gaelic. The first aim of this thesis is to explore the various ways in which the sound system of Scottish Gaelic can inform theories about the structure of the linguistic grammar. The second aim is to make a valuable contribution to the documentation and analysis of several aspects of Scottish Gaelic phonology.

Each chapter is a largely self-contained research paper that approaches the question of the structure of the linguistic grammar from a particular angle, either by presenting new data from Scottish Gaelic or by offering a detailed theoretical analysis of pre-existing data. First of all, ch. 2 presents an acoustic study of several patterns of vowel allophony in a dialect of Scottish Gaelic, and identifies phonological and phonetic sound patterns in the data. Secondly, ch. 3 (published as Morrison 2020) presents an articulatory study of the complex patterns of vowel nasalisation that occur in Scottish Gaelic, and searches for morphological effects in phonetic detail. Finally, chh. 4 (published as Morrison 2019) and 5 offer detailed analyses of two highly complex aspects of Scottish Gaelic phonology, *viz.* the prosodic contrast between *Class 1* and *Class 2* forms and the *broad–slender* opposition in consonants and vowels. In each case the data is found to be particularly amenable to an analysis in which the linguistic grammar is *modular* and/or *stratified*. Ch. 6 picks up some points of general discussion that are not suited to inclusion within any one individual paper, and ch. 7 concludes the thesis.

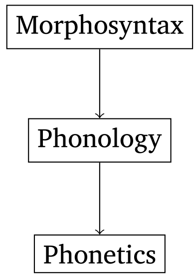
The structure of this introductory chapter is as follows. In §1.1 I provide a concise theoretical overview of the concepts of *modularity* and *stratification* in phonology, and in §1.2 I provide important background information on the sound inventory of Scottish Gaelic. These sections are placed here in order to avoid excessive duplication among the individual research papers, and will frequently be referred to throughout the thesis.

1.1 Modularity and stratification in phonology

A frequent and widespread assumption in the generative tradition is that the linguistic grammar is *modular* and *feedforward*. This means that it consists of a number of separate components, each concerned with a particular level of linguistic structure, and that information flows unidirectionally from one component to the next across a restricted number of *interfaces* (Pierrehumbert 2002; Bermúdez-Otero 2007: 501 ff.; Bermúdez-Otero 2012: 45 ff.; Bermúdez-Otero 2015: 377). A typical model is shown in Fig. 1.1. According to this architecture, morphs that are stored in the lexicon are assembled in the morphosyntax to form words and sentences, which then undergo phonological processing followed by phonetic interpretation. Crucially, each component has access only to that information which is present in the output of the one that feeds it. As discussed by Bermúdez-Otero (2007; 2015), the modular feedforward architecture of grammar meets with particular empirical success in its predictions about diachronic pathways of sound change. It predicts the distinction between lexically abrupt, phonetically gradual *neogrammarian* sound change (Labov 2010: ch. 13), which represents innovation in the phonetics, and phonetically abrupt, lexically gradual *lexically diffusing* change (Wang 1969), which represents innovation in the lexicon. It also predicts that sound patterns advance through the grammar along a well-defined diachronic pathway, known as the *life cycle* of phonological processes (Bermúdez-Otero 2007; 2011: §3; 2015; Bermúdez-Otero & Trousdale 2012: §2; Turton 2014; Ramsammy 2015).

Each module operates exclusively upon its own proprietary set of representational objects: the morphosyntax acts upon whole morphs, the phonology upon discrete phonological symbols (segments, features, prosodic nodes and association lines), and the phonetics upon continuous phonetic dimensions. One important prediction that follows from this is the Morph Integrity Hypothesis (Bermúdez-Otero 2012: 50), according to which the morphosyntax cannot alter the phonological content of morphs,

Figure 1.1: The modular feedforward architecture of grammar



but only select and arrange them. This means that all morphological operations must be entirely concatenative in nature. Stonham (1994) argues in favour of this view by offering concatenative analyses of superficially substitutional or subtractive processes in a number of languages. As it happens, Scottish Gaelic and the other Celtic languages are rife with such processes as part of their extensive systems of *initial mutation*; although a detailed analysis of the Scottish Gaelic initial mutations will not form part of this thesis, authors such as Lieber (1983; 1987), Wolf (2007) and Iosad (2014; 2017) offer accounts of initial mutation in which the relevant alternations are triggered by the affixation of featural autosegments, and this is the approach that I will assume whenever it is relevant to the analysis.

It also follows that sound patterns produced by phonological processes will be categorical in nature, while those produced by phonetic processes will be gradient. This is therefore the basis upon which observed sound patterns are usually deemed to be either phonological or phonetic (Ernestus 2011). One type of categoricity that may be observed is what I refer to as *distributional* categoricity, in which tokens are distributed bimodally in articulatory and/or acoustic space. Following Bermúdez-Otero & Trousdale (2012: 696), I consider distributional categoricity to be good evidence that a sound pattern belongs to the phonological grammar. This is supported by experimental evidence presented by Maye et al. (2002) showing that infants learn to discriminate tokens located at the endpoints of an acoustic continuum if and only if the tokens on which they are trained are distributed bimodally, which suggests that bimodality in the input is what prompts the learner to set up two discrete categories during acquisition. Ellis & Hardcastle (2002) find inter-speaker variation with respect to whether optional place articulation in English /n#k/ clusters leads to a bimodal distribution in the magnitude of the coronal gesture, i.e. tokens are either not assimilated or fully assimilated, or a gradient distribution, i.e. tokens are spread along a continuum ranging between these endpoints; this is interpreted by Bermúdez-Otero & Trousdale (2012: 694 ff.) as variation between a phonological rule and a phonetic one. Similarly, Turton (2014) identifies both phonological and phonetic processes of /l/-darkening in English speakers on the basis of bimodality in tongue position. In ch. 2 I apply this approach to several patterns of vowel allophony in a dialect of Scottish Gaelic, and demonstrate that the processes responsible are phonological in some speakers and phonetic in others.

Another type of categoricity may be observed, which I refer to as *dynamic* categoricity. If a segment S is specified for a feature F in the phonological output, then the phonetic property associated with F is expected to be manifested throughout the entire duration of S. However, if S is not specified for F in the phonological ouput but is adjacent to a segment that is, then S may display this phonetic property for part of its duration as a result of interpolation between different phonetic targets. Cohn (1990; 1993), employs this criterion in order to discriminate between phonological and phonetic processes of vowel nasalisation in several languages, identifying "plateau"-like patterns of nasal airflow with phonological nasalisation, and "cline"-like patterns with phonetic nasalisation. In ch. 3 I apply the same approach to vowel nasalisation in Scottish Gaelic, showing that both phonological and phonetic nasalisation occur.

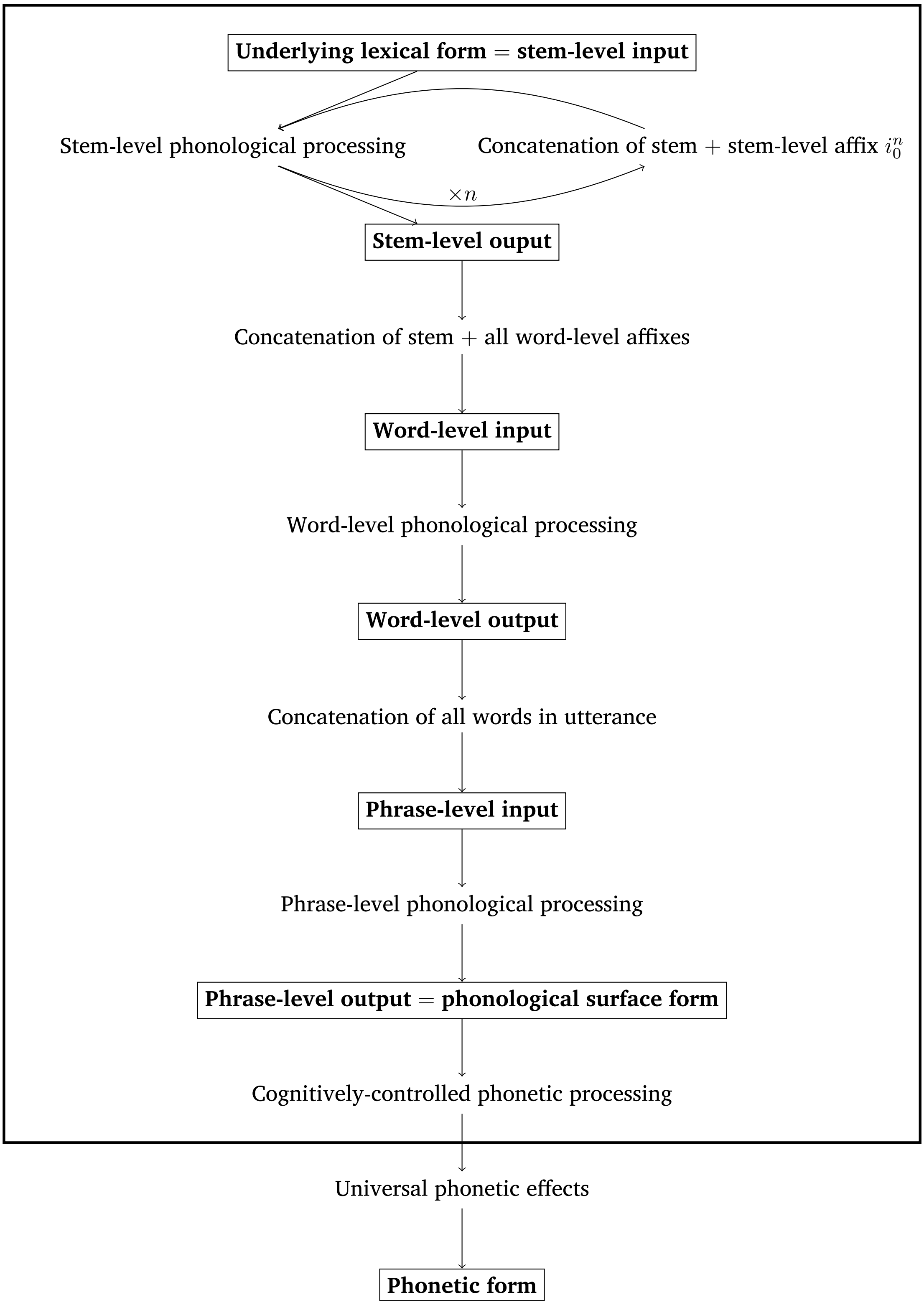
The modular feedforward architecture of grammar provides us with an empirically restrictive framework for linguistic analysis by tightly constraining the types of interactions that may occur between different levels of linguistic structure. For instance, the phonology has access only to the underlying forms of the morphs that are fed into it by the morphosyntax, and is blind to the semantic information with which these morphs are indexed in the lexicon. Additionally, the phonetics is sensitive only to the output of the phonology, and has no direct access to lexical or mophological information. In its unmodified form, this framework faces a considerable challenge from gradient effects of usage factors such as lexical frequency (Bybee 2001; Pierrehumbert 2002) and the widespread phenomenon of *incomplete neutralisation* (Ernestus 2011: §2.5; Kawahara 2011: §2.2.2), in which fine-grained phonetic detail displays sensitivity to lexical and morphological information respectively. Although the reconciliation of these observations with the empirical predicitions of modularity lies outwith the scope of this thesis, in ch. 3 I seek to constrain the types of morphological processes that may be subject to incomplete neutralisation by demonstrating that it does not occur in connection with the phenomenon of *initial mutation*. In line with the predictions of the modular architecture, it is found that only categorical phonological nasalisation, and not gradient phonetic nasalisation, is subject to morphological conditioning in Scottish Gaelic.

In this thesis I argue that phonology is *stratified*, meaning that different morphosyntactic domains are subject to different phonological rules. Specifically, I analyse phonological patterns within the framework of Stratal Optimality Theory (henceforth Stratal OT; Kiparsky 2000; Bermúdez-Otero 2011; 2012; 2015; 2018b; Bermúdez-Otero & Trousdale 2012), a modification of traditional Optimality Theory in which constraints may be re-ranked from one stratum to the next. This framework accounts for opacity in derived forms by means of *cyclicity*, whereby phonological processes may affect stems before the concatenation of affixes. In this respect it is primarily in competition with *output–output* (OO)-*correspondence* (Kenstowicz 1996; Benua 1997), according to which the surface representations of paradigmatically-related forms stand in a correspondence relationship with one another. Stratal OT, on the other hand, permits only *input–output* (IO-)*correspondence* between the input and output of a given phonological level.

A model of stratification in phonology is shown in Fig. 1.2, adapted from Bermúdez-Otero & Trousdale (2012: 700) and Bermúdez-Otero (2015: 378). All stages contained within the outer box belong to the linguistic grammar and are thus under cognitive control. Three phonological strata are identified, affecting stems, words and entire utterances respectively. A distinction is made between stem-level affixes, which trigger additional cycles of the stem-level phonology, and word-level affixes, which do not. This is well-motivated in the analysis of English, where it is possible to identify two types of affix traditionally referred to as “Level 1” and “Level 2” affixes. The former occur linearly closer to the stem and are more deeply integrated phonologically, affecting stress patterns for example, while the latter are invisible to stress. However, I have been unable to identify two morphological strata in Scottish Gaelic, so the distinction between stem-level and word-level affixes is not relevant to this thesis (but *cf.* Iosad 2018 for Irish).

First of all, the input to the stem-level phonology is the underlying lexical form. Any

Figure 1.2: Stratification in phonology



static distributional regularities observed in the data can be ascribed to the workings of the stem-level phonology. This follows from the principle of *richness of the base*, which forbids the stipulation of phonological restrictions on underlying forms. All phonotactic generalisations, including the limits of the sound inventory itself, must therefore be the result of high-ranked markedness constraints at the stem level. The stem-level phonology operates *cyclically*, meaning that the concatenation of each stem-level affix to the stem is followed by a further round of stem-level phonological processing.

Secondly, the concatenation of all word-level affixes to the stem is followed by a single round of word-level phonological processing. Since I have been unable to distinguish two morphological strata in Scottish Gaelic, I assume that all morphological operations that I encounter are word-level rather than stem-level. This assumption is heuristically motivated because it leads to fewer steps in the phonological derivation, so it would be uneconomical for either the analyst or the learner to assign an affix to the stem level without good reason. As a result, any phonological process that is observed to be fed or bled by morphological operations is assumed to belong to the word-level phonology.

Finally, the concatenation of all words in the utterance is followed by a single round of phrase-level phonological processing. Any phonological process that is observed to operate across word boundaries must belong to the phrase-level phonology. The output of the phrase-level phonology is the phonological surface form. This undergoes cognitively controlled phonetic processing, responsible for language-specific phonetic sound patterns, followed by universal phonetic effects that are not under cognitive control. This results in the observed phonetic form.

In chh. 4 and 5 I apply Stratal OT analyses to highly complex data sets from Scottish Gaelic. In ch. 4 I provide a metrical analysis of the contrast between *Class 1* and *Class 2* forms, which are distinguished on the surface by either tonal accent, glottalisation or overlength depending on dialect. Although the phonological class of a form is usually predictable from its overt surface segmental content, a number of highly opaque interactions occur. In ch. 5 I analyse the distribution of *broad* and *slender* vowels, showing that it is almost entirely predictable once we set up the correct underlying representations and account for numerous opaque interactions. In both cases, it is found that Stratal OT is capable of accounting for the highly complex patterns observed in a principled manner.

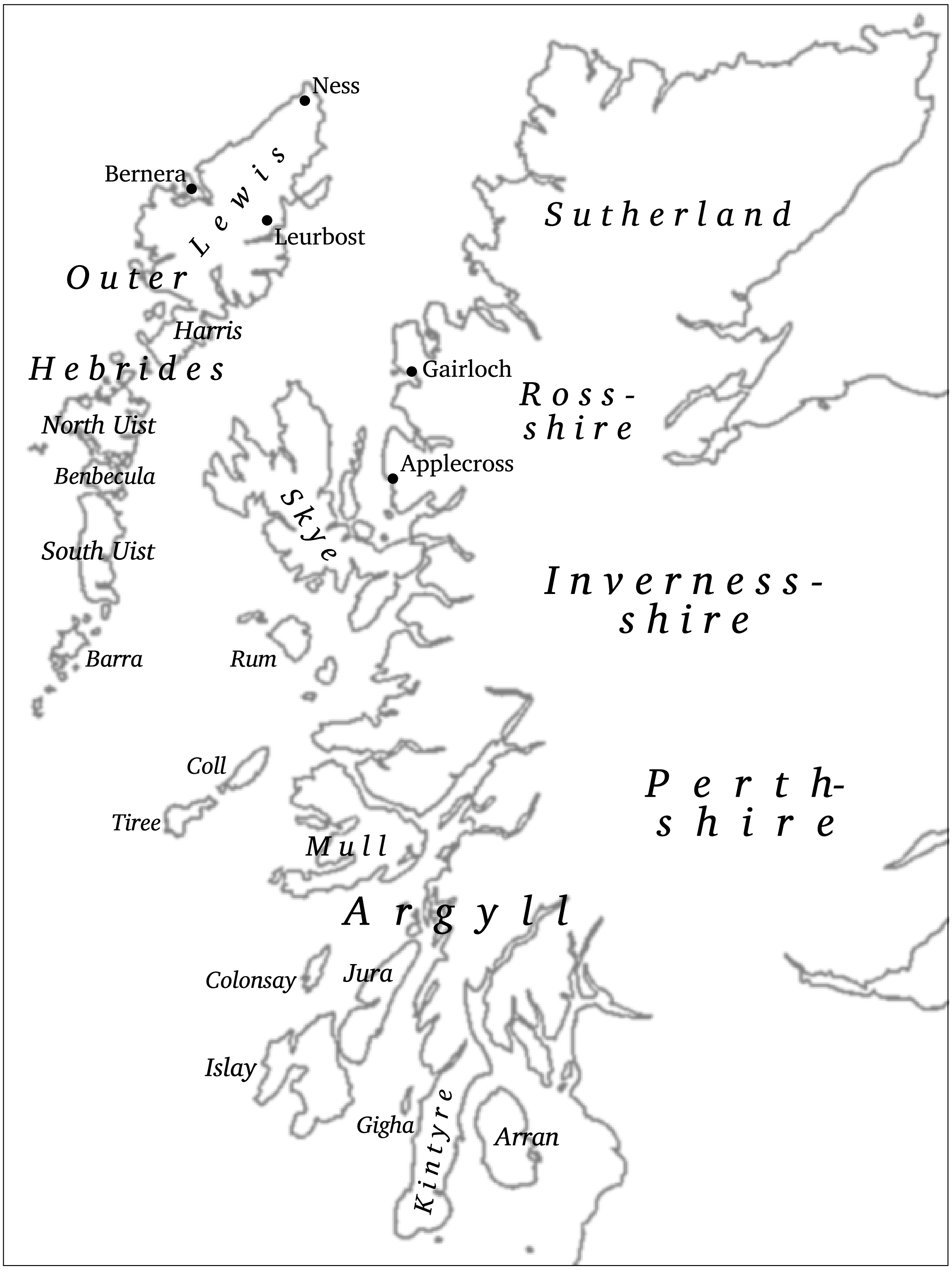
1.2 The sound inventory of Scottish Gaelic

Scottish Gaelic, alongside closely related Irish and Manx, belongs to the Goidelic subbranch of the Celtic language family, itself a branch of Indo-European. The Goidelic languages are descended from Old Irish, spoken in Ireland, the west of Scotland and the Isle of Man in the Early Mediaeval period (Stifter 2009). Scottish Gaelic today is spoken mostly in northwestern Scotland by speakers numbering approximately 60,000 according to the 2011 census (National Records of Scotland 2015). Although it has undergone rapid decline since the early 20th century (*see* e.g. MacKinnon 2010), it nevertheless remained the dominant language of acquisition among the native population of the Outer Hebrides until around the 1980s. A map of the traditionally Gaelic-speaking areas of Scotland, including the most important locations mentioned in this thesis, is shown in Fig. 1.3.

Beginning around the 1940s, a number of dialects of Scottish Gaelic have been documented in great detail by means of traditional dialect studies. These include the dialects of the Outer Hebrides (Borgstrøm 1937; 1940; Oftedal 1956), Islay (Holmer 1938; Grannd 2000), Skye (Borgstrøm 1941), western Ross-shire (Borgstrøm 1941; Ternes 1973; Wentworth 2005), Arran (Holmer 1957), Kintyre (Holmer 1962), the east coast of Sutherland and Ross-shire (Watson 1974; Dorian 1978), East Perthshire (Ó Murchú 1989) and Jura (Jones 2010). However, a vast central area of the mainland, covering Inverness-shire, North Argyll and West Perthshire, remains virtually undocumented. Our knowledge of these dialects, along with any others that have escaped detailed description, comes mostly from *SGDS* (*Survey of the Gaelic Dialects of Scotland*, Ó Dochartaigh 1994–97, data mostly collected 1951–63), which contains narrow phonetic transcriptions of several hundred words produced by speakers at over 200 locations spread throughout the traditionally Gaelic-speaking areas of Scotland. Overviews of the sound system of Scottish Gaelic in general can be found in Clement (1984), MacAulay (1992b), Ternes (1994), Gillies (2009) and Bosch (2010a).

Due to the diverse transcription practices employed in traditional dialect surveys of Scottish Gaelic, a large amount of normalisation has been necessary when citing

Figure 1.3: The traditionally Gaelic-speaking areas of Scotland, including specific locations mentioned in this thesis (outline from `https://d-maps.com/m/europa/uk/ecosse/ecosse04.gif`)



forms in this thesis. Although the forms cited here may therefore differ considerably from those in my sources both in terms of the symbols employed and the degree of phonetic detail included, I have endeavoured throughout to accurately mark all aspects of their pronunciation that are relevant in each case. Although most modern works, including this thesis, employ a version of the International Phonetic Alphabet, a number important points of variation and/or potential confusion are listed in Appendix A. These should be carefully noted. As an aid to the reader, the basic principles of Scottish Gaelic orthography are also outlined in Appendix B.

This thesis is mostly concerned with the dialect of Scottish Gaelic spoken in Lewis, which comprises the northern two thirds of the northernmost island in the Outer Hebrides. The dialect of Bernera, on the west side of Lewis, is described in detail by Borgstrøm (1940) and revisited more recently in a phonetic study by Ladefoged et al. (1998). Meanwhile, Oftedal (1956) provides a detailed description of the dialect of Leurbost in the east. The dialect of Ness, at the far northern end of Lewis, is the subject of a few pages of notes in Borgstrøm (1940), and Nance & Ó Maolalaigh (2019) provide an overview of the sound system of one Ness speaker. Ness is also the site of my own Scottish Gaelic fieldwork. Finally, *SGDS* includes survey data from nine speakers at various locations around Lewis (pts. 1–9). This section provides a brief overview of the sound inventory of Scottish Gaelic, focusing on the general Lewis Gaelic system that is mostly agreed upon across these sources. Consonants are discussed in §1.2.1, vowels in §1.2.2, and prosody in §1.2.3.

1.2.1 Consonants

The consonant phonemes of Lewis Gaelic are shown in Table 1.1. One important characteristic of all Scottish Gaelic dialects is the existence of contrastive palatalised and non-palatalised series among the coronal and dorsal consonants, traditionally referred to as *slender* and *broad* respectively. In ch. 5 I argue that labials and /h/ also display this contrast underlyingly.

When neither word-initial nor in the onset of a stressed syllable, the aspirated stops are pre-aspirated rather than post-aspirated. This is realised in Lewis as a short [h]-like period of glottal frication preceding the stop closure, i.e. [ʰp ʰt̪ ʰtʲ ʰk ʰkʲ], or as devoicing of an immediately-preceding sonorant. The ordinary short glottal pre-

Table 1.1: The consonant phonemes of Lewis Gaelic

	Labial	Coronal		Dorsal		Glottal
		Broad	**Slender**	**Broad**	**Slender**	
Stop	p^{h} p	t̪^{h} t̪	t^{jh} t^{j}	k^{h} k	k^{jh} k^{j}	
Fricative	f v	s	ʃ	x ɣ	x^{j} j	h
Nasal	m	N n	N^{j}			
Lateral		L	L^{j} l^{j}			
Rhotic		R r	r^{j}			

aspiration found at all places of articulation in Lewis distinguishes this dialect from the majority of other dialects of Scottish Gaelic, which instead mostly have clusters [hp ht̪ ht^{j} xk x^{j}k^{j}] or [xp xt̪ x^{j}t^{j} xk x^{j}k^{j}], or even no pre-aspiration at all (*see* Borgstrøm 1974; Ó Baoill 1981; Bosch 2010b; Clayton 2010: 36 ff.; Ó Maolalaigh 2010 for overviews of this variation). Note that, for simplicity, I transcribe pre-aspirated stops in underlying forms even though they can be regarded as positional allophones of the post-aspirated stops.

The sonorants of Scottish Gaelic are divided into *fortis* and *lenis* series, where fortis sonorants are, roughly speaking, more strongly articulated than lenis ones. The fortis–lenis dichotomy is reflected in various aspects of the behaviour of sonorants in Scottish Gaelic. For instance, only fortis sonorants occur in initial position in native lexical roots, only fortis sonorants trigger *lengthening* of a preceding tautosyllabic vowel or vowel epenthesis before a heterorganic pre-aspirated stop (*see* ch. 4), and certain cluster types may contain either only fortis sonorants or only lenis sonorants (*see* ch. 5). In order to emphasise this opposition among the complex system of coronal sonorants, I follow many other authors in employing an abstract notation with upper- and lower-case letters. Those coronal sonorants that are notated with upper-case letters, along with /m/, are fortis, while those notated with lower-case letters are lenis. The actual realisations of the coronal sonorants, for Lewis Gaelic, are shown in IPA in Table 1.2. Note that palatalisation on /l^{j} r^{j}/ is very weak in Lewis, while initial /N/ is at most very weakly velarised and as a result may be indistinguishable from /n/ in this position; Nance & Ó Maolalaigh (2019) also report that /R/ is merged with /r/ for their Ness speaker. The realisations shown in Table 1.2 generally also hold true for other dialects (to the extent that these contrasts are maintained at all), except that /r^{j}/ is normally a palatalised tap [ɾ^{j}], trill [r^{j}] or fricative trill [r̝^{j}] outwith Lewis, while /L/ has a diverse range of localised realisations, particularly in parts of Argyll, including

Table 1.2: The actual realisations of the coronal sonorants in Lewis Gaelic

Abstract notation	N	n	Nʲ	L	Lʲ	lʲ	R	r	rʲ
IPA	n̪ˠ	n	ɲ	l̪ˠ	ʎ	lʲ	rˠ	ɾ	ðʲ

[d̪ˠ d̪ˡˠ vˠ ðˠ l̪ʷ w] (*SGDS*).

This system represents a reduction of the ancestral Old Irish system, which displayed a full four-way contrast between broad fortis /N L R/, broad lenis /n l r/, slender fortis /Nʲ Lʲ Rʲ/ and slender lenis /nʲ lʲ rʲ/. Original slender lenis /nʲ/ is merged with either broad lenis /n/ or slender fortis /Nʲ/ depending on position, broad lenis /l/ with broad fortis /L/, and slender fortis /Rʲ/ with broad fortis /R/. While dialects outwith the Outer Hebrides often display further reductions of this system, or mergers in different directions, more conservative systems are also occasionally found. Although a four-way coronal nasal system has never been explicitly acknowledged in the descriptive literature on Scottish Gaelic, analysis of *SGDS* data reveals robust four-way nasal systems in three scattered mainland speakers (pts. 75, 171 and 207). Four-way lateral systems, on the other hand, where broad fortis /L/ and broad lenis /l/ remain distinct, are relatively well-attested. Oftedal (1975: 138 ff.; *see also SGDS* pts. 5 and 10) describes such a system on the westernmost fringes of Lewis and Harris, as does Holmer (1962: 27 ff.) for some Kintyre speakers, and analysis of *SGDS* data also reveals robust four-way systems in one speaker from North Uist (pt. 19) and another from East Perthshire (pt. 194). Additionally, in Islay, the original four-way contrast is maintained in initial position by de-lateralising initial broad fortis /L/ to [d̪ˠ∼d̪ˡˠ] or similar (Holmer 1938: 84; Grannd 2000; *SGDS* pts. 53–56).[1] As for the rhotics, however, no trace remains of the original contrast between broad fortis /R/ and slender fortis /Rʲ/ in any Scottish Gaelic dialect. In chh. 4 and 5 I argue that an underlying four-way contrast is synchronically recoverable in Lewis for both the nasals and the laterals, but not the rhotics.

Velar nasals [ŋ ŋʲ] occur before velar stops, and can be regarded as allophones of coronal nasals. In at least some other dialects, such as Skye (Borgstrøm 1941: 35–

[1]A claim by Hamp (1970) that a five-way contrast occurs intervocalically for both the nasals and the laterals in Islay is repeated in overviews by Ternes (1994: 103) and Lamb (2003: 18). In fact, there is a three-way qualitative contrast in Islay just as in Lewis, with /L=l/ vs. /Lʲ/ vs. /lʲ/, but intervocalic fortis nasals and laterals may also be lexically geminated, e.g. *cuimhne* [kʰuNʲːə] ‘memory’, *coinnlear* [kʰɤLʲːar] ‘candlestick’ (*SGDS* pts. 53–56). Somewhat misleadingly, Hamp treats the geminated fortis nasals and laterals as additional phonemes.

36), they can occur without a following velar stop and thus appear to have phonemic status. It is not clear whether these sounds should be classed as fortis or lenis.

In Lewis Gaelic the clusters /Rt̪ Rs RN RL/ undergo coalescence to velarised retroflex consonants [ʈˠ ʂˠ ɳˠ ɭˠ]. Although coalescence of /Rs/ to [ʂˠ] (or apico-alveolar [s̺ˠ]) occurs throughout a large region covering at least the Outer Hebrides, Skye and parts of the mainland, complete coalescence of /Rt̪ RN RL/ appears to be more or less restricted to Lewis. Outwith Lewis, /R/ is often reduced to a retroflex approximant [ɻˠ] in these clusters.

When either word-initial or in the onset of a stressed syllable, a nasal + stop cluster undergoes full or partial coalescence in many dialects of Scottish Gaelic. The relevant clusters occur almost exclusively as a result of a process that I refer to as *n-prothesis* (*see* ch. 5, §5.2.3). The possible outcomes of this coalescence generally lie along a continuum ranging from pure stops at one extreme, through pre-nasalised stops and post-stopped nasals to pure nasals at the opposite extreme. The outcome is typically breathy-voiced if the stop is underlyingly aspirated, and voiced if it is underlyingly unaspirated, although some varieties neutralise both series to voiced (*see* Bosch & Scobbie 2009 for detailed discussion of this variation). Lewis Gaelic tends towards the latter extreme, displaying either post-stopped nasals or pure nasals: breathy voiced [m$^{\text{(b)ɦ}}$ N$^{\text{(d̪)ɦ}}$ N$^{\text{(d)jɦ}}$ ŋ$^{\text{(g)ɦ}}$ ŋ$^{\text{(g)jɦ}}$] from nasal + aspirated stop, and voiced [m$^{\text{(b)}}$ N$^{\text{(d̪)}}$ N$^{\text{(d)j}}$ ŋ$^{\text{(g)}}$ ŋ$^{\text{(g)j}}$] from nasal + plain stop. Although post-stopped nasals are reported by both Borgstrøm (1940) for Bernera and Ness and Oftedal (1956) for Leurbost, and are frequently recorded in *SGDS* (data collected early 1960s) for Lewis speakers, it is likely that they have mostly or fully given way to pure nasals in the present-day Lewis system. MacAulay (1962, born 1930) reports only pure nasals in his own Bernera idiolect, which can be taken to represent a stage two or three generations later than Borgstrøm's informants, while Rogers (1972) reports only pure nasals for Point, and I believe I have only ever heard pure nasals in Ness; however, post-stopped nasals are recorded by Cox (2002, data collected mid-1980s) in a collection of toponyms from Carloway. Instrumental studies by Shuken (1979; 1980, 230 ff.) and Ladefoged et al. (1998) find only pure nasals.[2]

[2] One of Shuken's (1980) speakers occasionally produces unreduced nasal + stop clusters, which the author ascribes to hypercorrection.

Table 1.3: The monophthongal vowel phonemes of Lewis Gaelic

	Slender	Broad	
		Unrounded	Rounded
Close	i iː	ɯ ɯː	u uː
Close-mid	e eː	ɤ ɤː	o oː
Open-mid	ɛ ɛː		ɔ ɔː
Open		a aː	

1.2.2 Vowels

The monophthongal vowel phonemes of Lewis Gaelic are shown in Table 1.3. As with consonants, the traditional terms *slender* and *broad* are used to refer to front and non-front vowels respectively. In addition to the monophthongs in Table 1.3, there are also opening diphthongs /iə ia uə ua/ and numerous closing diphthongs such as /ui ei ɤi ai ɔu au/, although the exact inventory of closing diphthongs varies within Lewis. Long vowels and diphthongs are distinguished from hiatus sequences by pitch patterns (*see next section*).

A characteristic feature of the Lewis dialect is the existence of two highly distinct allophones of /u(ː)/: a true back vowel [u(ː)] next to velarised consonants, and a more central vowel [ʉ(ː)] elsewhere. This has been confirmed instrumentally by Ladefoged et al. (1998) and Nance (2011). When short, the true back allophone [u] also occurs before /x/ as well as, in some parts of Lewis, before /j/. This opposition, as well as several other allophonic oppositions investigated in ch. 2, is ignored in chh. 4 and 5 for simplicity.

Most stressed vowels and diphthongs may also occur with nasalisation. Vowel nasalisation in Scottish Gaelic is a complex phenomenon: stressed vowels display two degrees of nasalisation when next to nasal consonants, which I interpret in ch. 3 as categorical phonological nasalisation and gradient phonetic nasalisation, and may also be independently nasalised outwith this environment. Nasalisation is marked in chh. 2 and 3 whenever I believe it to be categorical and phonological, but it is again ignored in chh. 4 and 5 for simplicity.

A height-harmonic front glide [i̯~e̯~ɛ̯] may occur before a stressed broad vowel under certain circumstances, discussed in detail in ch. 5. While this is distinct from consonantal /j/ in most dialects, it merges with /j/ in the north and west of Lewis. I therefore transcribe it as [j] in chh. 2 and 3, which are concerned with the dialect of

Ness specifically.

The system of unstressed vowels can generally be reduced to three underlying qualities /ə a ɔ/. /ə/ has a conditioned variant [i] before certain palatalised consonants, especially slender dorsals and /N^j L^j/, although the exact set varies within Lewis. Unstressed [i] also occurs word-finally or before hiatus, where it can be taken to represent underlying /əj/ on the basis of morphological alternations (*see* ch. 5, §5.2.1). Unstressed [u] may also occur in the same environments, which I assume to represent underlying /əv/ on the basis of the relatively free variation between [u] and [əv] found in at least some dialects.

1.2.3 Prosody

Stress in Scottish Gaelic almost always occurs on the initial syllable, except in recent loans and in a closed class of forms, mostly adverbs of time and place, that begin with unstressed /ə/. There is no secondary stress except in compound words, where both components may carry a degree of stress. I explicitly mark stress only when it is non-initial.

Lewis Gaelic distinguishes two tonal accent classes: *Class 1* forms display an early pitch peak and *Class 2* forms display a later pitch peak. The same contrast is realised in some other dialects by means of glottalisation or overlength. In ch. 4 I show that this contrast reflects syllable structure, and that the pitch peak occurs on the rightmost mora of the stressed syllable. Hiatus sequences (Class 1) are thus distinguished from long vowels and diphthongs (Class 2), and ordinary VCV sequences (Class 1) from *svarabhakti groups* (Class 2). I transcribe tonal accent only in ch. 4, where the phonetics and phonology of this opposition are discussed in detail. In all other chapters it is ignored for simplicity, although the contrast is indirectly marked, where applicable, through the presence (Class 1) or absence (Class 2) of hiatus in VV sequences.

Chapter 2

Phonetic and phonological patterns of vowel allophony

2.1 Introduction

Scottish Gaelic is almost universally described as displaying a system of nine monophthongal vowel qualities, including two back unrounded vowels and a contrast between open-mid and close-mid vowels (e.g. Clement 1984; MacAulay 1992b; Ternes 1994; Gillies 2009; Bosch 2010a), both of which set it apart from most dialects of its sister language Irish (e.g. Ó Dochartaigh 1984; 1992; Mac Eoin 1993; Ó Baoill 2009). This paper describes the vowel system of the dialect of Ness, at the far northern end of Lewis, which differs from the general Scottish Gaelic system discussed in ch. 1, §1.2.2 in several important ways. As well as lacking some of the phonemic contrasts found in other dialects, several vowels display allophonic variation in Ness that has not been investigated instrumentally, and in some cases has never been reported in the existing literature for this or any other dialect of Scottish Gaelic. First of all, the short front vowels /i e/ both display tense and lax allophones whose distribution is governed by the following consonantal environment – while the existence of some sort of conditioned variation in the quality of /i/ has been reported before for various dialects, the tense and lax allophones of /e/ in Ness correspond in quality to two vowels that are generally considered to be phonemically contrastive in Scottish Gaelic. Secondly, both short and long /a(:)/ display a retracted allophone when adjacent to a velarised consonant, which has also been reported in some other locations. This paper first lays out the findings of a descriptive study of the Ness Gaelic vowel system based on traditional linguistic fieldwork methods, and then presents an acoustic study of nine speakers that provides instrumental support for these findings and explores the nature of the aforementioned allophonic oppositions.

Although other Lewis dialects are thoroughly documented by Borgstrøm (1940), Oftedal (1956) and Ladefoged et al. (1998), very little literature exists on the Ness dialect specifically, apart from some brief notes in Borgstrøm (1940) and an examination of one speaker by Nance & Ó Maolalaigh (2019). Ness is also represented by pt. 1 in *SGDS*. This study therefore provides vital documentation of the vowel system of a dialect that is, in certain ways, somewhat divergent from existing descriptions of Scottish Gaelic. The allophonic patterns reported here, whose existence is hitherto either unreported in the existing literature or known only from Borgstrøm's (1940) notes, are subjected to instrumental investigation for the first time.

The categoricity of these oppositions is investigated by searching for bimodality in the acoustic distribution of tokens (Bermúdez-Otero & Trousdale 2012: 696), and it is concluded that speakers vary as to whether tense and lax /i e/ can be shown to be represented by two discrete categories in the phonological grammar. In the case of retraction of /a(:)/, it is found that similar inter-speaker variation occurs in the long vowel, while no speakers display categoricity in the short vowel. This variation is framed in terms of the diachronic process of *stabilisation*, in the context of the *life cycle* of phonological processes (Bermúdez-Otero 2007; 2011: §3; 2015; Bermúdez-Otero & Trousdale 2012: §2).

The phonetic grounding of the allophonic patterns reported here is also considered. While the retraction of /a(:)/ next to velarised consonants can probably be attributed to co-articulation, the motivation for the distribution of tense and lax /i e/ is less obvious. A solution is offered based on a generalised version of Storme's (2019) analysis of the laxing of vowels in closed syllables in languages such as French, where laxing serves to enhance the perceptual distinctiveness of an immediately-following supra-glottal consonant by allowing for more distinctive formant transitions.

The structure of the paper is as follows. §2.2 presents a descriptive study of the vowel system of Ness Gaelic, while §2.3 presents an acoustic study that supports these findings. §2.4 provides some general discussion and §2.5 concludes the paper.

2.2 Ness Gaelic vowels: Descriptive study

Ness, at the far northern end of Lewis, consists of a dense cluster of around 14 villages mostly strung along a main road from southwest to northeast for a distance of around 6 km. In this section I provide the results of a descriptive study of the vowel system of Ness Gaelic conducted using traditional linguistic fieldwork methods, based primarily on highly detailed observation of the speech of one male informant born in 1952 in the village of Adabrock (speaker S1 in the experiment described in §2.3). My findings are discussed in the context of the existing literature on Ness Gaelic and on Lewis Gaelic more generally.

The primary informant was born and raised in Ness but spent a considerable portion of his adult life living on the Scottish mainland before returning to the same village. Forms were elicited and transcribed by the author, who is not a native speaker of the variety in question, by means of informal conversation in English on a day-to-day basis over a number of years. This was complemented on occasion by passive observation of the spontaneous speech of other members of the community.

The consonant system of Ness differs little from the general Lewis system described in ch. 1, §1.2.1. My primary informant frequently pronounces /N/ as a retroflex [ɳˠ] in non-initial position – such a pronunciation has never been reported before for Ness, but it is occasionally recorded in *SGDS* for speakers on the east coast of Lewis, e.g. *chunnaic* [xuɳˠikʲ] 'see.PST' (pt. 6, Tolsta), *ceannaich* [kʲʰɑɳˠixʲ] 'buy' (pt. 7, Point).

This section is concerned with the vowel system of Ness Gaelic, which differs in various ways from the general Lewis system described in ch. 1, §1.2.2. For comparison with Table 1.3, the Ness system described here is summarised in Table 2.1. Only stressed monophthongs are considered in this paper. The absence of /ɯ ɛː/ is discussed in §2.2.1 and §2.2.2 respectively, the tense and lax allophones of /i e/ in §2.2.3 and §2.2.4 respectively, and retraction of /a(ː)/ in §2.2.5.

2.2.1 Absence of /ɯ/

As a distinctive characteristic of the Ness dialect, Borgstrøm (1940: 120) reports that wherever Bernera has short [ɯ] followed by a slender consonant, Ness has [i]:

Table 2.1: The monophthongal vowel phonemes of Ness Gaelic

	Front		Non-front	
			Unrounded	**Rounded**
Close	i~ɪ	iː	ɯː	ʉ~u ʉː~uː
Near-close				
Close-mid	e~ɛ	eː	ɤ ɤː	o oː
Open-mid				ɔ ɔː
Open			a~ɑ aː~ɑː	

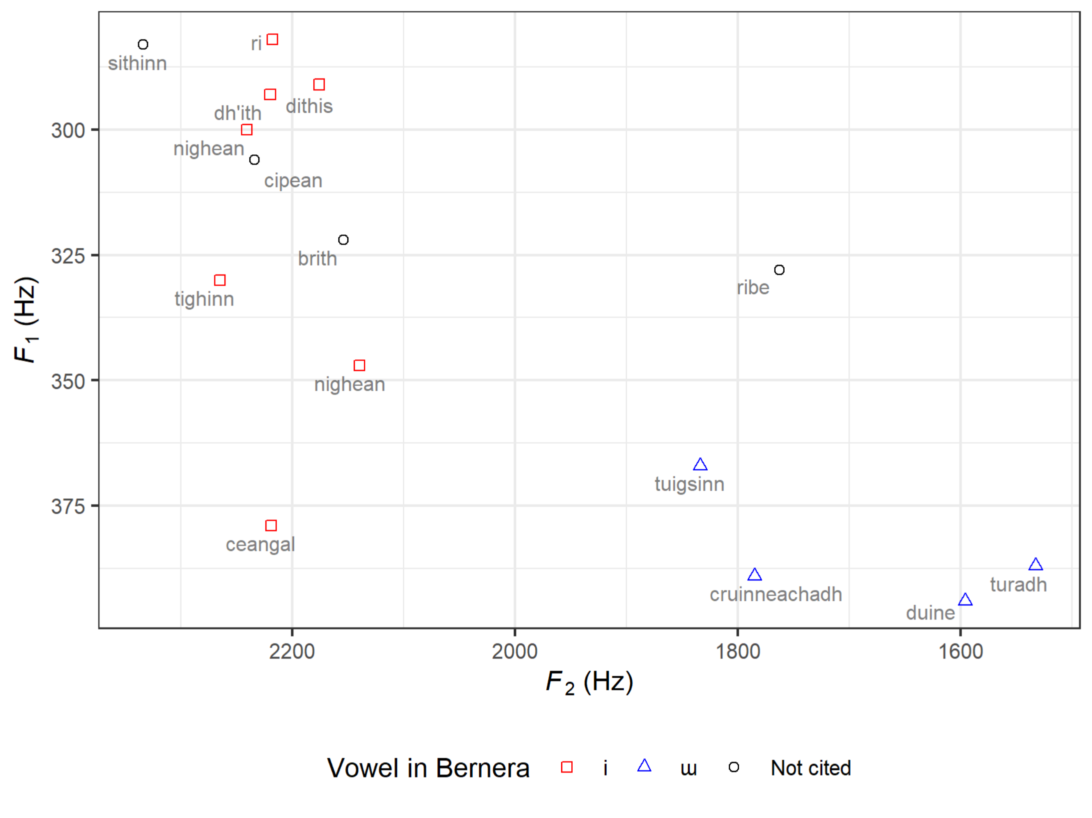
(1)

	Bernera	**Ness**	
duine	[t̪ɯNʲə]	[t̪iNʲə]	'man'
ruig	[Rɯkʲ]	[Rikʲ]	'reach'
tuilleadh	[t̪ʰɯLʲəɣ]	[t̪ʲiLʲəɣ]	'more'
uisge	[ɯʃkʲ]	[iʃkʲ]	'rain'

This is in agreement with my own observations for Ness Gaelic. As it happens, [ɯ] in Bernera is nearly always followed by a slender consonant, meaning that Borgstrøm's rule covers the vast majority of occurrences of this vowel while theoretically leaving unchanged only a small number of forms that display it in other environments, e.g. Bernera *turadh* [t̪ʰɯrəɣ] 'dry weather'. However, as will be discussed in §2.2.3, the lax allophone of /i/ in Ness Gaelic is often retracted so far as to occupy the region of vowel space where /ɯ/ would be expected to occur. Since the vowel of *turadh*, and the few other items that Borgstrøm's rule fails to cover, occurs in an environment where /i/ would be expected to display its lax allophone, it can in fact simply be assigned to underlying /i/ in the context of the Ness system. The same can probably be said for the three forms that are recorded in *SGDS* with [ɯ] in Ness, *viz. earball* [ɯrɯpəL] 'tail', *iodhal* [jɯɣaL] 'idol', *lugha* [Lɯɣə] 'small.CMP'. I therefore consider /ɯ/ to be fully merged with /i/ in this system, even though vowels that I regard as positional allophones of /i/ may often be somewhat [ɯ]-like in quality.

Nance & Ó Maolalaigh (2019) nevertheless report two phonemes /i/ and /ɯ/ in their Ness speaker. Fig. 2.1, produced using their supplementary audio files, shows the distribution in vowel space of all forms containing either of these vowels in a stressed syllable. Where applicable, these are coded according to the vowel with which they are recorded in Bernera by Borgstrøm (1940). As far as it is possible to tell, this speaker perfectly reproduces the Bernera system – note in particular the occurrence of [ɯ]

Figure 2.1: The distribution in vowel space of forms containing either /i/ or /ɯ/ in Nance & Ó Maolalaigh (2019), coded according to the vowel with which they are recorded in Bernera by Borgstrøm (1940)



before slender consonants in *cruinneachadh* [kʰrɯNʲəxəɣ] ‘gather.VN’, *duine* [t̪ɯNʲə] ‘man’, *tuigsinn* [t̪ʰɯkʲʃiNʲ] ‘understand.VN’, in stark contradiction to the characteristic Ness system established by Borgstrøm (1940), analysis of *SGDS* data, and my own observations.[1] It therefore appears that their speaker actually resists this Ness merger. This may be one example of the occasional levelling of dialectal features alluded to by Nance & Ó Maolalaigh (2019: 1), which results from this speaker’s time spent in Glasgow among speakers of other Scottish Gaelic dialects.

2.2.2 Absence of /ɛː/

Borgstrøm (1940: 27 ff.) records two distinct long mid front vowels /eː/ and /ɛː/ in Bernera, and makes no mention of any deviation from this in his notes on Ness. However, both Borgstrøm (1940: 27) and Oftedal (1956: 57) note that long /ɛː/ is somewhat higher than its short counterpart /ɛ/, encroaching on the territory of /eː/, and

[1] Note that Nance & Ó Maolalaigh (2019) transcribe these forms inconsistently, with [ɯ] in *cruinneachadh* and *turadh* only and [i] in all other items.

this is confirmed instrumentally for Bernera by Ladefoged et al. (1998: 27). According to my own observations, and in agreement with Nance & Ó Maolalaigh's (2019: 8) findings, /ɛː/ is in fact fully merged with /eː/ in Ness.[2] Items that Borgstrøm records with [ɛː] in Bernera therefore have [eː] in Ness:

(2)	**Bernera**	**Ness**	
cnàimh	[kʰrʲɛ̃ːv]	[kʰrʲẽːv]	'bone'
Gàidheal	[kɛː.əL]	[keː.əL]	'Gael'
nèamh	[Nʲɛ̃ːv]	[Nʲẽːv]	'heaven'
's e	[ʃɛː]	[ʃeː]	'it is'

To the best of my knowledge, [ɛː] is recorded in *SGDS* only twice for Ness, in two instances of the word *cnàimh*. The handful of words which display [ɛː] elsewhere in Lewis are nearly always transcribed with [eː] not only in Ness but also in Tolsta (pt. 6) and Point (pt. 7) on the east coast, suggesting a near-total loss of /ɛː/ in a contiguous area covering the northeast quarter of the island. Outwith Lewis, a similar absence of /ɛː/ is reported by Dorian (1978: 58) for East Sutherland.

2.2.3 Tense and lax /i/

Many of the more detailed descriptions of Scottish Gaelic dialects (Borgstrøm 1940: 29, 120, 136; 1941: 18, 71; Oftedal 1956: 64; Dorian 1978: 56; Wentworth 2005: 172 ff.) report the existence of a somewhat retracted and lowered allophone of /i/ in various environments, most commonly before certain broad consonants. As far as I am aware, however, this allophony has never been investigated instrumentally. Borgstrøm (1940: 120) singles out Ness as a dialect in which this retraction and lowering is particularly strong – so much so that he introduces a separate symbol *ι* for it in his transcription system, alongside ordinary *i*. According to my own observations, the fully close front allophone, which I refer to as *tense* and transcribe [i], occurs in Environment A. On the other hand, the retracted and lowered allophone, which I refer to as *lax* and transcribe [ɪ], occurs in Environment B. Note that /lʲ rʲ/ do not appear to pattern with other

[2] Note that Nance & Ó Maolalaigh (2019) transcribe [ɛː] in *Gàidheal* [kɛː.əL] 'Gael' and (nasalised) in *sèimh* [ʃɛ̃ːv] 'gentle', and open-mid /ɛː/ is included in an un-captioned vowel diagram on p. 7. However, the text on p. 8, the formant plot in Fig. 2 on p. 8, and inspection of the supplementary audio files all indicate that this vowel is merged with /eː/ for their speaker.

slender consonants in this respect – recall from ch. 1, §1.2.1 that they are normally pronounced with only very weak palatalisation:

(3) a. Tense [i] in Environment A:

i. Word-finally or before hiatus, /h/ or a pre-aspirated stop

fitheach	[fi.əx]	'raven'	*miotag*	[mĩʰt̪ak]	'glove'
frithir	[frʲihərʲ]	'impatient'	*nigh*	[Nʲĩ]	'wash'

ii. Before a slender consonant (excluding /lʲ rʲ/)

bris	[prʲiʃ]	'break'	*gille*	[kʲiLʲə]	'boy'
duine	[t̪iNʲə]	'man'	*ruig*	[Rikʲ]	'reach'

b. Lax [ɪ] in Environment B: Before any other consonant

fios	[fɪs]	'knowledge'	*siud*	[ʃɪt̪]	'that'
milis	[mĩlʲəʃ]	'sweet'	*turadh*	[t̪ʰɪrəɣ]	'dry weather'

The few examples provided by by Borgstrøm (1940: 120) in his notes on Ness are largely consistent with the pattern in (3), but *cf.* e.g. tense [i] in Environment B in *min* [mĩn] 'meal'.

While the tense allophone [i] is similar in quality to long /iː/, the lax allophone [ɪ] often approaches the quality of long /ɯː/ (which tends to be more central than back in Lewis, and not fully close). As stated in §2.2.1, a form such as *turadh* [t̪ʰɪrəɣ] 'dry weather' can therefore be considered to display the lax allophone of /i/ in the context of the Ness system, even though its vowel likely differs little in quality from Bernera /ɯ/.

Although the rule in (3) can be taken as a starting point, speakers appear to vary slightly with respect to the precise conditioning environments of the two allophones. This means that lax [ɪ] may occasionally be heard in Environment A and tense [i] in Environment B – although the requirement that only tense [i] occur word-finally or before hiatus, /h/ or a pre-aspirated stop appears to be absolute. One informant asserted that the lexical distribution of tense and lax /i/ differs from one end of Ness to the other, with some words, e.g. *giomach* [kʲiməx~kʲɪməx] 'lobster', displaying tense [i] at the southwest end and lax [ɪ] at the northeast end. This would result in lax [ɪ] being more frequent in general in the northeast of Ness. He explicitly associated this variation with the catchment areas of the two primary schools that served the area until the early 2000s: one in Cross serving the southwestern half of Ness, and one in Lionel serving the northeastern half.

There are 61 forms recorded in *SGDS* with either [i] or [ɪ] in Ness. Of the 55 that contain Environment A, 48 have tense [i] and just seven have lax [ɪ]. Conversely, of the six that contain Environment B, all except one have lax [ɪ]. This speaker therefore displays a clear trend towards the pattern in (3), but does not maintain it consistently. Lax [ɪ] is occasionally recorded at other locations in Lewis as well, albeit less frequently than in Ness, and among these the Tolsta (pt. 6), Carloway (pt. 4) and Leurbost (pt. 8) speakers display traces of a similar trend.

2.2.4 Tense and lax /e/

/e/ and /ɛ/ are generally considered to be phonemically contrastive in Scottish Gaelic, although both Borgstrøm (1940: 12) and Oftedal (1956: 58) note that the opposition is neutralised in a large number of environments: for instance, in Bernera, only /e/ occurs between slender consonants and only /ɛ/ before /t̪ s x r/. Ó Maolalaigh (1997) explores whether they can be reduced to a single phoneme in the system described by Oftedal (1956) for Leurbost, and concludes that it is not possible. Borgstrøm's (1940: 119) notes on Ness suggest that the relative lexical distribution of these two vowels is roughly as in Bernera. According to my own observations, however, they are in perfect complementary distribution in the Ness system, representing two positional allophones of a single phoneme which I will label /e/. [e], which I refer to as the *tense* allophone, occurs in Environment A, while [ɛ], which I refer to as *lax*, occurs in Environment B. Note that this rule is identical to the rule for /i/, except that a following slender consonant does not cause tenseness:

(4) a. Tense [e] in Environment A: Word-finally or before hiatus, /h/ or a pre-aspirated stop

ceithir	[kʲʰehərʲ]	'four'	*soitheach*	[se.əx]	'vessel'
faic	[fẽʰkʲ]	'see'	*teth*	[tʲʰe]	'hot'

b. Lax [ɛ] in Environment B: Before any other consonant

bean	[pɛn]	'wife'	*eilean*	[ɛlʲan]	'island'
deich	[tʲɛxʲ]	'ten'	*teas*	[tʲʰɛs]	'heat'

While the tense allophone [e] is similar in quality to long /eː/, the lax allophone [ɛ] is lower and less fully front than this. For some Ness speakers – especially my primary informant – the lax allophone tends to be retracted so far as to render it indistinguishable in quality from /ɤ/. Borgstrøm (1940: 119) reports this retraction in Ness only before /k/, e.g. *beag* [pɤk] 'small', *freagairt* [frɤkət̪ˠ] 'answer', where other dialects normally have [e]. The former of these two words occurs in *SGDS*, where it is transcribed with [ɤ] in both Ness and Point (pt. 7) and with [e] elsewhere in Lewis. Nance & Ó Maolalaigh's (2019) Ness speaker has [ɤ] in both these words as well as (nasalised) before /ɣ/ in *teanga* [tʲʰɤ̃ɣə] 'tongue', which has [ɛ̃] in other dialects but usually [ĩ] in Ness (*cf.* Borgstrøm 1940: 239).[3]

There are 42 forms recorded in *SGDS* with either [e] or [ɛ] in Ness. Of the 21 that contain Environment A, 16 have tense [e] and five have lax [ɛ]. Conversely, of the 21 that contain Environment B, all except one have lax [ɛ]. As with tense and lax /i/ in the previous section, this speaker therefore displays a clear trend towards the pattern in (4) but does not maintain it consistently. Outwith Ness, speakers throughout the east coast of Lewis (pts. 6–9) show similar traces of this pattern while those on the west coast (pts. 2–5) do not.

Nance & Ó Maolalaigh (2019) report two phonemes /e/ and /ɛ/ in their Ness speaker, and do not discuss their relative distribution. However, as shown in Fig. 2.2, produced using their supplementary audio files, the distribution of these two vowels almost totally conforms to the pattern in (4). The only clear exception is *teinne* [tʲʰeNʲə] 'tight.CMP', which has tense [e] in Environment B (although *aige* [ɛkʲə] 'at.3SG.M' displays an anomalous value for F_2 as a result of poor formant tracking caused by creaky voice).[4]

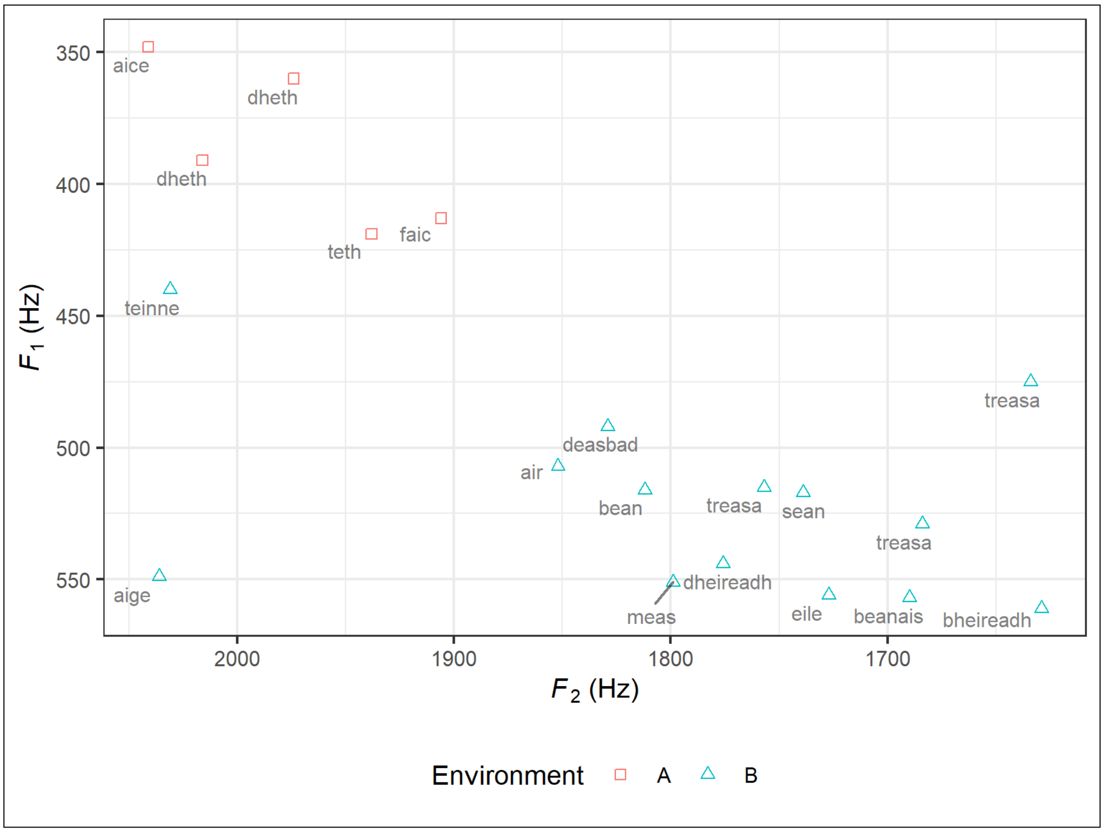
2.2.5 Retraction of /a(ː)/

Borgstrøm (1940: 119) notes that /a(ː)/ in the Ness dialect, unlike that of Bernera, is characterised by the occurrence of a retracted allophone [ɑ(ː)] when it occurs next to velarised consonants. This is parallel to the allophony in /u(ː)/ throughout Lewis

[3]Note that *teanga* is incorrectly transcribed [tʃʰɛ̃kə] in Nance & Ó Maolalaigh (2019).

[4]Note that the word *eile* [ɛlʲə] 'other' is incorrectly transcribed with [e] in Nance & Ó Maolalaigh (2019), but their speaker actually produces [ɛ] as expected. Another word, *leig* [lʲikʲ] 'let.PST', is transcribed with [e] but actually appears to be produced with [i] in accordance with the usual Lewis pronunciation (*cf.* Borgstrøm 1940: 69; Oftedal 1956: 243).

Figure 2.2: The distribution in vowel space of forms containing either /e/ or /ɛ/ in Nance & Ó Maolalaigh (2019), coded for Environment A or B



mentioned in ch. 1, §1.2.2, except that a following /x/ or /j/ does not trigger retraction in /a/. According to my own observations, this retraction occurs next to all velarised consonants except initial /N/ – recall from ch. 1, §1.2.1 that this consonant displays at most very weak velarisation in initial position in Lewis. It therefore occurs before (but not after) /N/, before and after /L/, and before and after /R/. Additionally, it occurs before the velarised retroflex consonants [ʈˠ ʂˠ ɳˠ ɭˠ] representing underlying clusters /Rt̪ Rs RN RL/. Note that long /aː/ is either extremely rare or non-existent before /N/, so no examples are given; note also that [ʂˠ] is the only retroflex consonant that may be preceded by a short stressed vowel:

(5) a. Before /N/

fannaich [fɑNixʲ] 'weaken'

greannach [krʲɑNəx] 'angry'

b. Before /L/

balach [pɑLəx] 'boy' *àlainn* [ɑːLiNʲ] 'beautiful'

geal	[kʲɑL]	'white'	*sàl*	[sɑːL]	'seawater'

c. After /L/

blas	[pLɑs]	'taste'	*blàth*	[pLɑː]	'warm'
cladach	[kʰLɑt̪əx]	'shore'	*làidir*	[Lɑːtʲərʲ]	'strong'

d. Before /R/

earrach	[jɑRəx]	'spring'	*bàrr*	[pɑːR]	'cream'
starrag	[st̪ɑRak]	'crow'	*gàrradh*	[kɑːRəɣ]	'garden'

e. After /R/

rag	[Rɑk]	'numb'	*ràcan*	[Rɑːʰkan]	'rake'
rapach	[Rɑʰpəx]	'rough'	*ràn*	[Rɑːn]	'cry'

f. Before retroflex

arspag	[ɑʂˠpak]	'gull'	*gàirdean*	[kɑːʈˠan]	'arm'
ceart	[kʲʰɑʂʲʈʲ]	'correct'	*mèirleach*	[mjɑ̃ːɭˠəx]	'thief'

Morphologically-triggered *slenderisation* (*see* ch. 5, §5.2.1) of final /L/ can lead to alternations, e.g. *càl* [kʰɑːL] 'cabbage', genitive *càil* [kʰaːlʲ]. In the case of initial /R/, the *lenition* mutation (*see* ch. 5, §5.2.2) also leads to alternations in the vowel, e.g. *ràcan* [Rɑːʰkan] 'rake', *dà ràcan* [t̪aː raːʰkan] 'two rakes'.[5]

This retraction is also noted by Nance & Ó Maolalaigh (2019: 8) for their Ness speaker. A similar opposition is also reported by Oftedal (1956: 52–53) for Leurbost, and *SGDS* shows frequent retraction at all locations in Lewis except for the speaker nearest to Bernera (pt. 4, Carloway). It therefore appears to be fairly characteristic of Lewis Gaelic in general, except for, coincidentally, the area where Borgstrøm (1940) happened to carry out the majority of his fieldwork. Retraction in the same environment is also reported in some other locations further afield, e.g. Applecross, Ross-shire (Ternes 1973: 146).

There is one further environment in which this retraction may occur in Ness Gaelic. While the pre-aspirated stop /ʰk/ and the cluster /xk/ are normally distinct in Lewis Gaelic, e.g. *tac* [t̪ʰaʰk] 'farm', *seac* [ʃaʰk] 'wither' vs. *tachd* [t̪ʰaxk] 'choke', *seachd*

[5] Recall from ch. 1, §1.2.1 that Nance & Ó Maolalaigh (2019) find that /R/ is merged with /r/ for their Ness speaker. Nevertheless, retraction of both /a(ː)/ and /u(ː)/ is clearly audible in the supplementary audio files in words where /R/ is expected, e.g. *beàrr* [pjɑːr] 'cut', *b' urrainn* [puriNʲ] 'can.PST'. It therefore may be the case that this merger has brought about marginal phonemicisation of these vocalic oppositions in this speaker.

[ʃaxk] 'seven', some Ness speakers – including my primary informant – merge both to [ʰk]. When this occurs, the contrast appears to be transferred to a preceding short /a/, which is retracted before underlying /xk/, e.g. *tac* [t̪ʰaʰk], *seac* [ʃaʰk] vs. *tachd* [t̪ʰɑʰk], *seachd* [ʃɑʰk]. This is in spite of the fact that retraction does not occur before [xk] in those speakers who do have this cluster, and no speakers have retraction of /a/ before /x/ in general. Note that long /aː/ is extremely rare before /xk/, so it is not clear whether it would be subject to retraction under the same circumstances.

2.3 Ness Gaelic vowels: Acoustic study

In this section I describe an acoustic study of the Ness Gaelic vowel system that investigates instrumentally the allophonic patterns described in §2.2. The aims of the experiment are discussed in §2.3.1, the methods in §2.3.2 and the results in §2.3.3.

2.3.1 Aims

The first aim of this study is to document the vowel system of Ness Gaelic, focusing on those parts where it differs from the general Lewis system described in ch. 1, §1.2.2. Since the rounded vowels of Ness Gaelic display no noteworthy departure from this system, only unrounded vowels will be investigated.

The second aim of this study is to determine whether the patterns of allophonic variation described in §2.2 for /i e a(:)/ in Ness Gaelic, which are hitherto based almost entirely upon auditory observation, can be verified acoustically by measuring formant values. It is predicted that /i e/ will display a higher first formant F_1 and a lower second formant F_2 in Environment B than in Environment A (as defined separately for the two vowels), because the lax allophone of each vowel is retracted and lowered with respect to the tense allophone. It is also predicted that /a(:)/ will display lower F_2 in retracting environments than in non-retracting environments.

The third aim is to search for evidence of bimodality in the distribution of tense vs. lax /i/, tense vs. lax /e/, and retracted vs. non-retracted /a(:)/ in individual speakers, and determine whether or not all speakers display similar patterns to one another. As discussed in ch. 1, §1.1, Bermúdez-Otero & Trousdale (2012: 696) argue that bimodality in the distribution of tokens can be taken as conclusive evidence for the presence of two discrete phonological categories in a speaker's grammar (although the absence of bimodality does not necessarily entail the absence of categoricity). If tokens of tense and lax /i e/, or retracted and non-retracted /a(ː)/, are distributed bimodally in vowel space, then I take this as an indication that the rule governing their distribution belongs to the categorical phonology rather than the gradient phonetics. For those speakers for whom it is possible to identify two separate categories, it will also be noted whether or not all items fall into the expected category according to the rules given in §2.2. However, no systematic attempt will be made to redefine those rules in the event that a particular speaker deviates from the expected distribution, since this would require the use of a very large number of different stimuli.

As noted in §2.2.3, there is anecdotal evidence of microdialectal variation within Ness with respect to the lexical distribution of tense and lax /i/, with lax [ɪ] more frequent at the northeast end than the southwest end. Systematic investigation of this variation is not an aim of this study, since this would require a large number of speakers and stimuli, but it will be noted whether or not any inter-speaker variation in the distribution of tense and lax /i/ is consistent with such a pattern.

2.3.2 Methods

Speakers

Table 2.2 provides details of the nine native speakers of Scottish Gaelic who took part in the study, including gender, year of birth and village of birth (marked according to whether the village is located in the southwestern half of Ness or the northeastern half). All were born and raised in Ness and lived there at the time of recording, although speakers S1, S2 and S6 had spent a significant portion of their adult lives living on the Scottish mainland – a factor which Ladefoged et al. (1998: 25) suggest may lie behind the loss of vocalic distinctions among some of their speakers. All used Scottish Gaelic on a daily basis either at home, in the community, or both. Speakers S1, S2 and S7 are siblings. All were sufficiently literate in Scottish Gaelic to participate in the study without difficulty.

Table 2.2: The nine speakers who took part in the study

Speaker	Gender	Year of birth	Village of birth
S1	Male	1952	Adabrock (NE)
S2	Male	1948	Adabrock (NE)
S3	Male	1943	Cross (SW)
S4	Male	1984	Cross (SW)
S5	Male	1951	Lionel (NE)
S6	Male	1950	Aird Dell (SW)
S7	Female	1951	Adabrock (NE)
S8	Female	1981	South Dell (SW)
S9	Female	1965	Eoropie (NE)

Table 2.3: The distribution of target vowels in the 144 stimuli used in the word list

Short vowels			Long vowels		
Vowel	**Environment**	n	**Vowel**	**Environment**	n
/i/	A	9	/iː/	n/a	8
	B	7			
			/ɯː/	n/a	8
/e/	A	8	/eː/	n/a	8
	B	8			
/a/	Non-retracting	28	/aː/	Non-retracting	12
	Before /N/	4			
	Before /L/	4		Before /L/	4
	After /L/	4		After /L/	4
	Before /R/	4		Before /R/	4
	After /R/	4		After /R/	4
	Before retroflex	4		Before retroflex	4
	Before /xk/	4			

Word list

The word list consisted of 144 stimuli containing the vowels /i(ː) ɯː e(ː) a(ː)/ in the stressed syllable. This set of vowels represents all of the unrounded monophthongal vowel phonemes of Ness Gaelic except for /ɤ(ː)/, which is relatively rare and is not included in this study. Effort was made to include as wide a variety of phonological environments as possible in each case, in order to avoid artificially inducing bimodality into the token distributions.

The numerical distribution of the target vowels among the 144 stimuli is shown in Table 2.3. After the recording of the first three participants, S1, S2 and S7, two problematic stimuli were replaced with similar words for the remaining participants. The full word list can be found in Appendix C.

Each participant was presented with a different iteration of the randomised word list. Stimuli were presented in Scottish Gaelic orthography, alongside an English gloss to provide clarification in the event that a participant failed to recognise a word from its orthographic form. Participants were instructed to read aloud each stimulus three times within the carrier sentence *'S e ... a chanas mi* [ʃe … ə xanəs mi] 'It is … that I will say'.

Recording

Recording was carried out in Praat (Boersma 2001) in a quiet room using a Logitech AK5370 USB desktop microphone connected directly to a computer. 3,865 tokens were successfully obtained, after a small number (less than 1%) were discarded either due to unclear pronunciation or due to an unexpected pronunciation that did not contain any of the target vowels (conversely, a handful of extra tokens were gained "for free" when speakers accidentally read a word four times instead of three).

Analysis

The start and end point of the target vowel of each token was determined using waveforms and spectrograms in Praat, and the quality of the vowel was identified auditorily. This was carried out at the phonemic level only, i.e. no attempt was made to auditorily distinguish between tense and lax /i e/ or between retracted and non-retracted /a(:)/, since the categoricity of these oppositions is in question. Nasalisation was ignored, since it displays very little interaction with vowel quality in this dialect. Each token was coded for vowel and, where relevant, for environment. If a token was produced with an unexpected vowel, it was retained and coded accordingly as long as the vowel used belonged to the set of target vowels – for instance, several speakers pronounced *teanga* 'tongue' as [tʲʰɛ̃ɣə] instead of expected [tʲʰĩɣə], so these tokens were coded with /e/ instead of /i/. Any relevant variant pronunciations by individual speakers are noted in Appendix C.[6] All speakers except for S1, S2 and S7 (the siblings from Adabrock) produced *beag* [pɤk] 'small' and *freagairt* [frɤkət̪ˠ] 'answer' with a vowel that was clearly distinct from their usual pronunciation of lax /e/ (*cf.* Borgstrøm 1940: 119), so these tokens were discarded since /ɤ/ is not one of the target vowels; however, for S1, S2 and S7 the vowel in these words was identified with their lax /e/.

[6]Most of the unexpected pronunciations, e.g. [ɛ̃] in *teanga* 'tongue', are attested elsewhere in Lewis and therefore may simply reflect the use of a slightly less dialectally marked variant. Only in the case of S2 and S7's use of [ã:] in *cnàimh* 'bone' is it likely that orthographic influence is playing a role.

Tokens representing underlying /xk/ after /a/ were coded separately only for those speakers who realised it as [^{h}k], *viz.* S1, S5, S7 (sister of S1) and S8, since it is only in this situation that it counts as a retracting environment; for the remaining speakers, who realised it as [xk], this was coded as a non-retracting environment just like any other following /x/.

Values for the first formant F_1 and the second formant F_2 were extracted using a Praat script at the temporal midpoint of each target vowel.[7] Formant tracking was then checked and, where necessary, corrected manually using Formant Editor (Sóskuthy 2015). A number of tokens were discarded at this stage due to unclear formants, and a further two tokens from speaker S7 were later discarded due to extreme outlying values for F_1 even after attempted manual correction. Ultimately, 3,811 useable tokens were retained. Formant values were then normalised for each speaker using the *S*-centroid method following Fabricius et al. (2009), taking each speaker's mean formant values for long /iː/ and /aː/ to represent the top-left and bottom-centre corners of the vowel space respectively. This produced dimensionless normalised formant values $F1_{norm}$ and $F2_{norm}$ that could be compared across speakers. Vowel durations were extracted using a Praat script by calculating the interval between the start and end point of each target vowel.

Because the laxing of /i e/ involves both retraction and lowering of the vowel, the tense and lax allophones are expected to be distributed diagonally in F_1–F_2 space relative to one another. A combination of both F_1 and F_2 values is therefore required in order to quantify the degree of tenseness displayed by a given token. This can be achieved by defining the tenseness T of a token of /i/ or /e/ as follows, where c is a constant whose value reflects the relative contribution of F_1 and F_2 to tenseness:

(6) $T = c \times F2_{norm} - F1_{norm}$

Since the tenseness of a token of /i e/ appears to be conditioned by its environment, the most intuitively meaningful measure of tenseness is the one that most effectively differentiates between tokens in Environment A and those in Environment B. The optimum value of c can therefore be taken to be that which minimises the variance of T

[7]Most of the analyses presented in this paper were also repeated using token means taken across seven evenly spaced timepoints covering the middle 75% of the vowel. Except where otherwise stated, the results did not differ substantially.

in the individual environments A and B relative to the overall variance of T in both environments combined. It is therefore the value that minimises the ratio r, defined as follows:

(7) $$r = \frac{n_A \times Var(T_A) + n_B \times Var(T_B)}{n \times Var(T)}$$

If tokens in Environments A and B are distributed as expected, plotting r against potential values of c will reveal a single minimum in r at a particular value of c. Using this method, separate values c_i and c_e were determined for /i/ and /e/ respectively based on the combined data of all nine speakers. This provided a means to quantify *i*-tenseness T_i and *e*-tenseness T_e, such that lax tokens of /i e/ display lower values of T_i and T_e respectively than tense tokens.

Because the retraction of /a(ː)/ almost exclusively affects F_2, the value of F_{2norm} alone was used to quantify the degree of retraction displayed by a given token. Retracted tokens display lower values of F_{2norm} than non-retracted tokens.

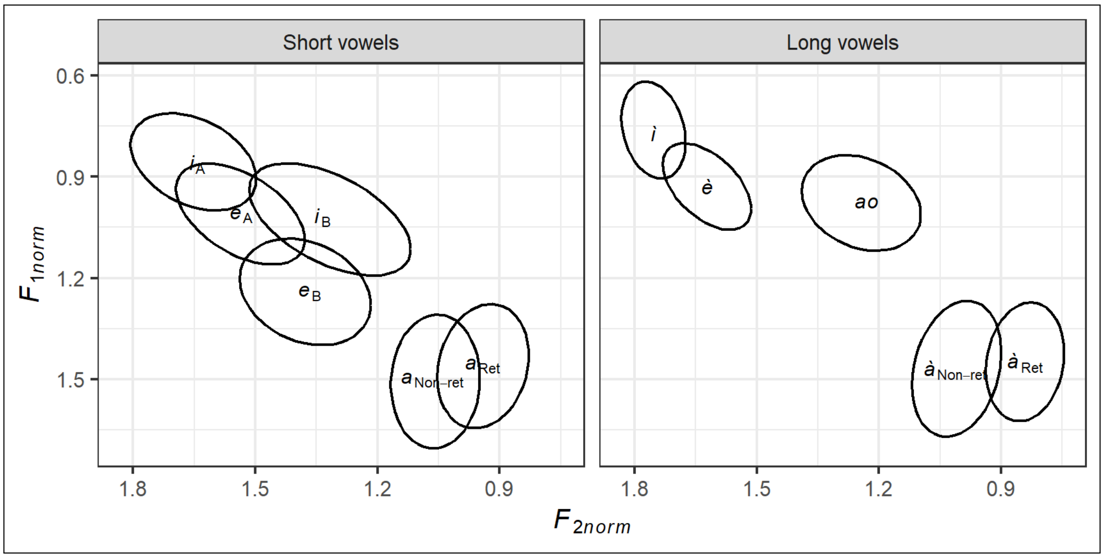
Linear mixed effects (LME) models were fitted in R (R Core Team 2017) using the `lme4` (Bates et al. 2015) and `lmerTest` (Kuznetsova et al. 2017) packages in order to determine whether the patterns of allophonic variation described in §2.2 for /i e a(ː)/ in Ness Gaelic can be confirmed statistically. Bimodality in the distribution of tokens was provisionally identified through visual inspection of density plots, and then investigated statistically by means of Hartigan's Dip Test for multimodality (Hartigan & Hartigan 1985) using the `diptest` package (Maechler 2016).

2.3.3 Results

Overall vowel system

Based on combined data from all nine speakers, the distribution of the target vowels in normalised vowel space is shown in Fig. 2.3. Note that /i/ in Environment B is highly retracted and lowered relative to Environment A, and occupies a similar area of vowel space to /ɯː/, while /e/ in Environment B occurs further down the front diagonal than in Environment A. Note also that /a(ː)/ occurs further back in retracting environments than in non-retracting environments.

Figure 2.3: The distribution of the target vowels in normalised vowel space, combined for all nine speakers. The labels *i e a* represent /i e a/ respectively; *ì ao è à* represent /iː ɯː eː aː/. Labels are centred on the mean, and ellipses represent one standard deviation from the mean.



Tense and lax /i/

The distribution of tokens of /i/ in normalised vowel space in Environments A and B is shown for each speaker in Fig. 2.4. Following the procedure described in §2.3.2, the optimum value of the constant c_i was determined to be 4.47. Therefore *i*-tenseness T_i is defined as follows:

(8) $T_i = 4.47 \times F_{2norm} - F_{1norm}$

The distribution of T_i according to environment is shown in the boxplots in Fig. 2.5. All speakers display a clear tendency for tokens in Environment B to have higher F_{1norm} and lower F_{2norm}, and thus lower T_i, than those in Environment A.

In order to determine whether this allophonic variation can be confirmed statistically, an LME model was fitted with *i*-tenseness T_i as the dependent variable and a fixed effect of environment (two levels: A, B). Unless otherwise stated, all LME models reported in this paper also include a random intercept in speaker, a random slope in speaker by environment, and a random intercept in stimulus, each of which significantly contributed to the fit according to LRTs in every case. A random slope in stimulus by environment was not included in any case as this did not significantly improve fit. The model is summarised in Table 2.4. Tokens of /i/ in Environment B display significantly lower T_i than those in Environment A.

Figure 2.4: The distribution of tokens of /i/ in normalised vowel space in Environments A and B for each speaker. Selected reference values of T_i are indicated with diagonal grey lines in order to facilitate comparison with Figs. 2.5 and 2.6.

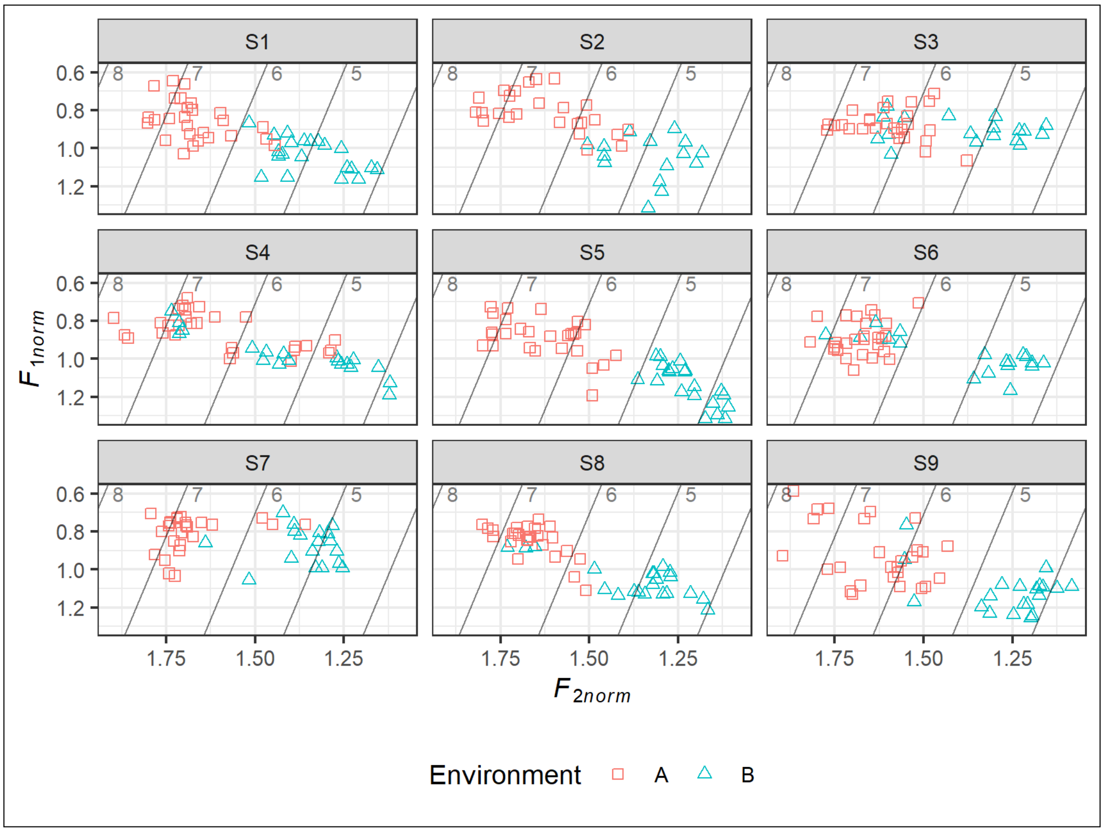


Figure 2.5: T_i of /i/ in Environments A and B for each speaker

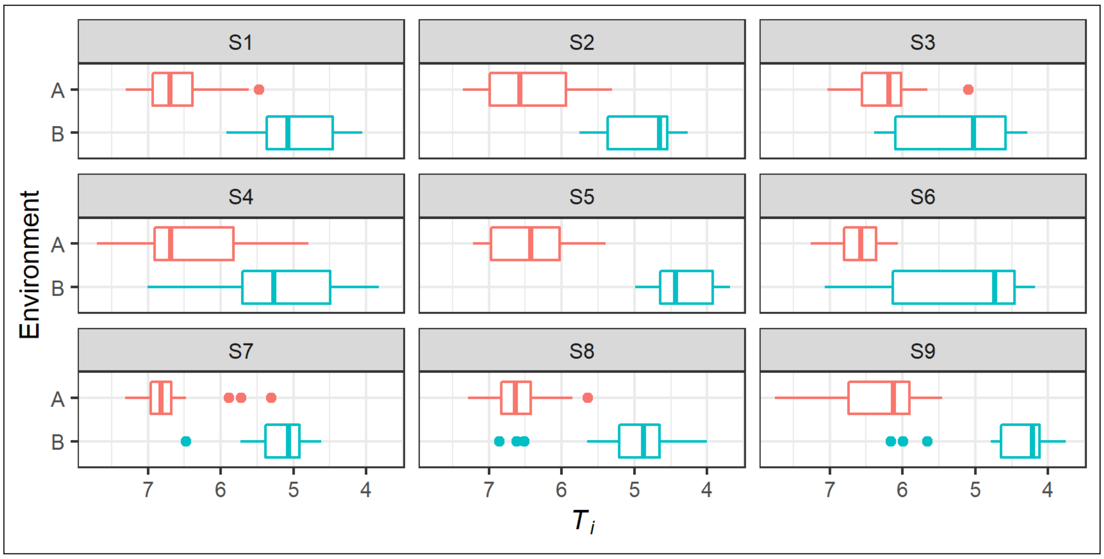


Table 2.4: LME model summary for T_i of /i/ against environment

Fixed effects	**Estimate**	SE	df	t	p	
(Intercept)	6.48	0.14	19.27	45.22	$< .001$	***
Environment = B	−1.52	0.22	22.45	−6.78	$< .001$	***

Table 2.5: LME model summary for T_i of /i/ against duration

Fixed effects	**Estimate**	SE	df	t	p	
(Intercept)	5.63	0.25	31.67	22.77	$< .001$	***
Duration (ms)	0.0013	0.0012	273.88	1.05	$.294$	n.s.

In many languages, such as English and German, there exists a close correlation between tenseness and vowel length, with short vowels displaying a lax quality relative to their long counterparts. It has therefore been proposed that tense–lax contrasts are derived from underlying length contrasts (Lindau 1978: 557). In order to investigate the possible effect of duration on tenseness in Scottish Gaelic, a fixed effect of duration was added to the model in Table 2.4. This did not significantly improve the fit of the model ($\chi^2(1) = 1.02$, $p = .312$). A further model, summarised in Table 2.5, was fitted with duration as the sole fixed effect and random intercepts in speaker and stimulus. Duration alone is not a significant predictor of T_i.

In order to search for evidence of categoricity in the distribution of tense and lax /i/, the density distribution of tokens of /i/ with respect to T_i in Environments A and B is plotted for each speaker in Fig. 2.6. All speakers except for S2 and S3 display clear visible signs of bimodality, defined as the presence of a pronounced dip in the overall distribution near to the point where the density curves for the separate environments cross.

Hartigan's Dip Test for multimodality was carried out in order to determine whether the presence of bimodality in the overall distribution of tokens of /i/ could be confirmed statistically for any of those seven speakers. The results are shown in Table 2.6. To account for multiplicity, significance was assessed by means of the Holm-Bonferroni method (Holm 1979). After this correction, speaker S9 displays significant evidence of bimodality, meaning that at least this individual can be said to display two phonological categories for /i/, but the apparent bimodality displayed by the other speakers cannot be confirmed statistically.[8] However, since this may be due to the noisiness of the data and the relatively small sample size per speaker, this should not necessarily be taken as evidence against the presence of categoricity in the other speakers.

For each of those speakers who display visible signs of bimodality, the location of

[8] When the analysis was repeated using token means instead of midpoints (*see* footnote 7), no speaker displayed significant evidence of bimodality.

Figure 2.6: The density distribution of tokens of /i/ with respect to T_i in Environments A and B for each speaker. The solid grey curve represents the overall distribution.

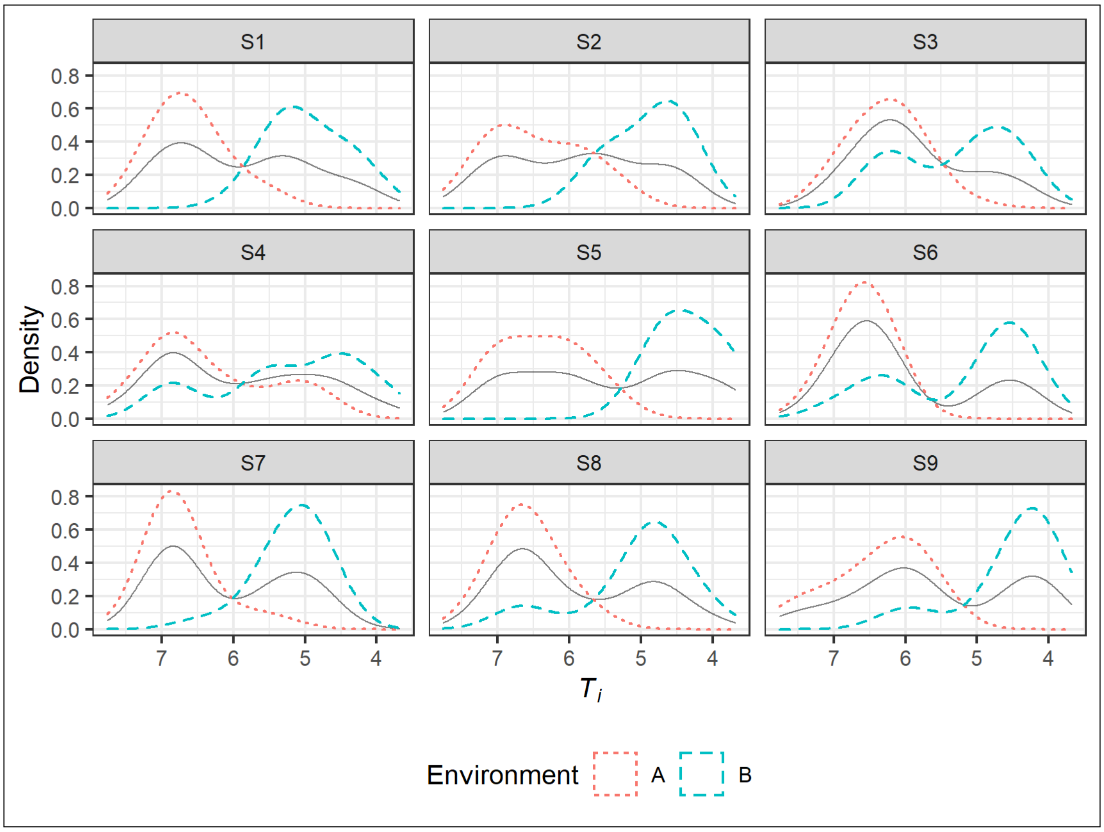


Table 2.6: Results of Hartigan's Dip Test for multimodality in those speakers who display visible signs of bimodality in T_i of /i/

Speaker	D	n	p	
S1	0.057	48	.265	n.s.
S4	0.062	47	.178	n.s.
S5	0.068	48	.085	n.s.
S6	0.077	45	.033	n.s.
S7	0.081	43	.022	n.s.
S8	0.074	48	.038	n.s.
S9	0.087	48	.005	*

the dip was taken as an estimate of the location of the boundary between the two (putative) categories, in order to establish whether individual words display the expected distribution according to the rule in (3). For all seven speakers, the majority of tokens fall on the expected side of the dip. However, *giomach* [kʲiməx] 'lobster' is consistently tense for S6 while *mil* [mĩl̃ʲ] 'honey' is consistently tense for S4, S6, S8 and S9, all of whom are from the southwestern end of Ness except for S9.[9] Conversely, *bruich* [prɪxʲ] 'boil' is consistently lax for S1 and S7, who are siblings from the northeastern end of

[9]For both S7 and S8, one out of three tokens of *giomach* [kʲiməx∼kʲɪməx] 'lobster' falls on the tense side of the dip.

Table 2.7: LME model summary for T_e of /e/ against environment

Fixed effects	Estimate	SE	df	t	p	
(Intercept)	-0.29	0.040	14.05	-7.33	$< .001$	***
Environment = B	-0.32	0.045	16.84	-7.10	$< .001$	***

the district, while *duine* [t̪ɪNʲə] ‘man’ and *tuilleadh* [t̪ʰɪLʲəɣ] ‘more’ are consistently lax for S4. This is therefore largely consistent with the anecdotal evidence mentioned in 2.2.3 regarding microdialectal variation in the lexical distribution of tense and lax /i/, although no firm conclusions may be drawn from the data available.

Tense and Lax /e/

The distribution of tokens of /e/ in normalised vowel space in Environments A and B is shown for each speaker in Fig. 2.7. Again following the procedure described in 2.3.2, the optimum value of the constant c_e was determined to be 0.47, so *e*-tenseness T_e is defined as follows:

(9) $T_e = 0.47 \times F_{2norm} - F_{1norm}$

The distribution of T_e according to environment is shown in the boxplots in Fig. 2.8. Again, all speakers display a clear tendency for tokens in Environment B to have higher F_{1norm} and lower F_{2norm}, and thus lower T_e, than those in Environment A. Note that the lax allophone is particularly strongly retracted for S1.

In order to determine whether this allophonic variation can be confirmed statistically, an LME model was fitted as before, this time with *e*-tenseness T_e as the dependent variable and a fixed effect of environment (two levels: A, B). The model is summarised in Table 2.7. As with /i/, tokens of /e/ in Environment B display significantly lower T_e than those in Environment A.

In order to once again investigate the possible effect of duration, a fixed effect of duration was added to the model in Table 2.7. This did not significantly improve the fit of the model ($\chi^2(1) = 2.15$, $p = .142$). A further model, summarised in Table 2.8, was fitted with duration as the sole fixed effect and random intercepts in speaker and stimulus. This time there was a small but significant effect, with tokens of greater duration displaying slightly greater T_e.

As before, the density distribution of tokens of /e/ with respect to T_e in Environ-

Figure 2.7: The distribution of tokens of /e/ in normalised vowel space in Environments A and B for each speaker. Selected reference values of T_e are indicated with diagonal grey lines in order to facilitate comparison with Figs. 2.8 and 2.9.

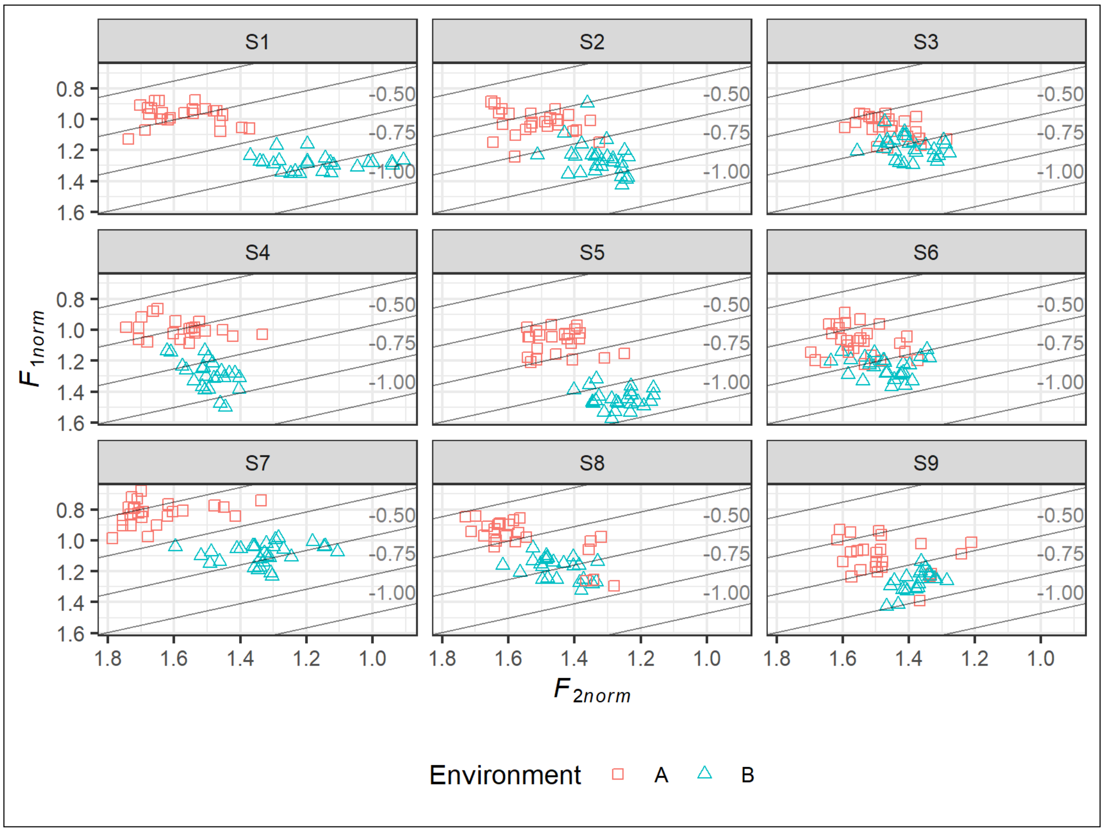


Figure 2.8: T_e of /e/ in Environments A and B for each speaker

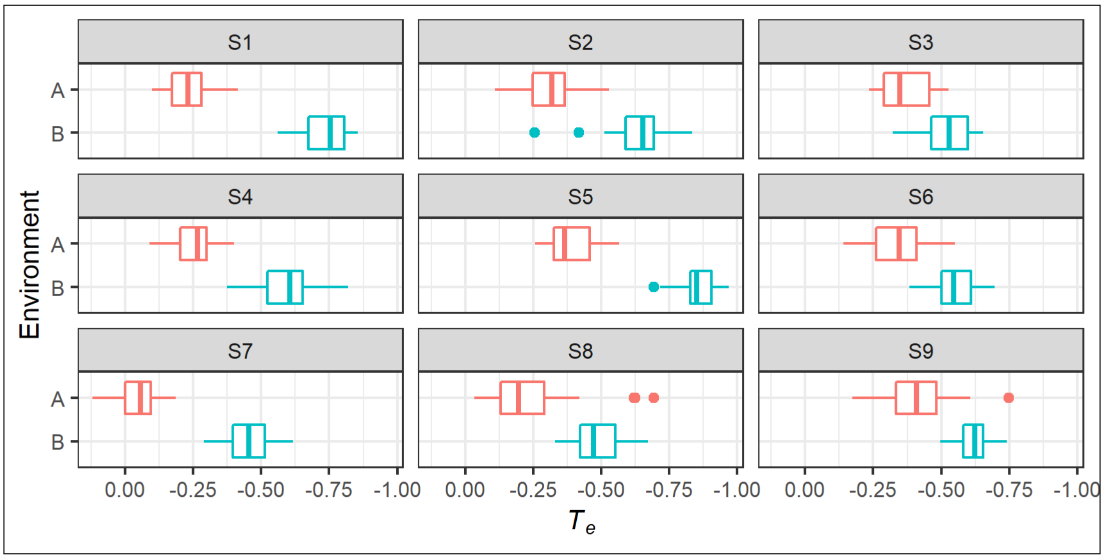
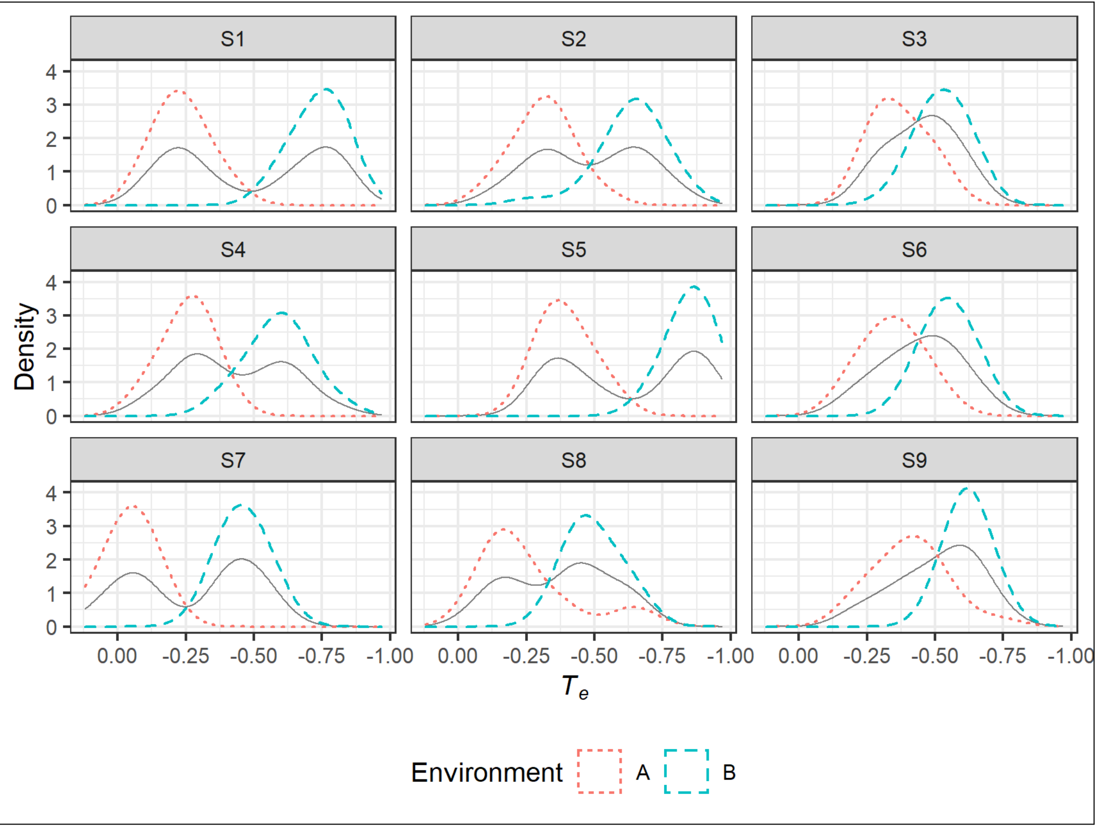


Table 2.8: LME model summary for T_e of /e/ against duration

Fixed effects	**Estimate**	SE	df	t	p	
(Intercept)	-0.55	0.059	46.16	-9.29	$< .001$	***
Duration (ms)	5.70×10^{-4}	2.39×10^{-4}	440.94	2.39	.017	*

Figure 2.9: The density distribution of tokens of /e/ with respect to T_e in Environments A and B for each speaker. The solid grey curve represents the overall distribution.



ments A and B is plotted for each speaker in in Fig. 2.9. All speakers except for S3, S6 and S9 display clear visible signs of bimodality.

Hartigan's Dip Test for multimodality was again carried out in order to determine whether the presence of bimodality in the overall distribution of tokens of /e/ could be confirmed statistically for any of those six speakers. The results are shown in Table 2.9. As before, significance was assessed by means of the Holm-Bonferroni method. Speakers S1, S5 and S7 display significant evidence of bimodality, meaning that at least those three individuals can be said to display two phonological categories for /e/, but the apparent bimodality displayed by S2, S4 and S8 cannot be confirmed statistically.[10]

By again taking the location of the dip as an estimate of the location of the boundary between the two (putative) categories for each of those speakers who display visible signs of bimodality, it was possible to establish whether individual words display the expected distribution according to the rule in (4). For all six speakers, the majority

[10]When the analysis was repeated using token means instead of midpoints (*see* fn. 7), only S1 displayed significant evidence of bimodality.

Table 2.9: Results of Hartigan's Dip Test for multimodality in those speakers who display visible signs of bimodality in T_e of /e/

Speaker	D	n	p	
S1	0.10	48	$< .001$	**
S2	0.062	51	.129	n.s.
S4	0.062	46	.189	n.s.
S5	0.096	48	$< .001$	**
S7	0.089	54	.001	**
S8	0.061	48	.188	n.s.

of tokens fall on the expected side of the dip. However, *breac* [prʲɛʰk] 'trout' and *reic* [Rɛʰkʲ] 'sell' are consistently lax for S8.[11]

Retraction of /a(:)/

The distribution of tokens of short /a/ in normalised vowel space in retracting and non-retracting environments is shown for each speaker in Fig. 2.10, and F_{2norm} is shown in the boxplots in Fig. 2.11. All speakers display a clear tendency for tokens in retracting environments to have lower F_{2norm} than those in non-retracting environments. Note that only speakers S1, S5, S7 (sister of S1) and S8 display the merger of /xk/ and /ʰk/ discussed in §2.2.5, so this particular retracting environment is found only in these speakers.

An LME model was fitted with F_{2norm} as the dependent variable and a fixed effect of environment (eight levels: non-retracting, before /N/, before /L/, after /L/, before /R/, after /R/, before retroflex, before /xk/). The model is summarised in Table 2.10. Relative to non-retracting environments, tokens of short /a/ display significantly lower F_{2norm} in every retracting environment except before /xk/.[12]

Closer inspection of stimuli with /a/ before /xk/, for those four speakers who display the merger of /xk/ and /ʰk/, reveals that retraction in this environment is highly inconsistent. Only S5 maintains a clearly audible distinction in both of the minimal pairs *tac* [t̪ʰaʰk] 'farm' vs. *tachd* [t̪ʰɑʰk] 'choke' and *seac* [ʃaʰk] 'wither' vs. *seachd* [ʃɑʰk] 'seven'. S1 distinguishes only the former pair in the recording, even though I

[11]For S2, one out of three tokens of both *deich* [tʲexʲ∼tʲɛxʲ] 'ten' and *teanga* [tʲʰẽɣə∼tʲʰɛ̃ɣə] 'tongue' fall on the tense side of the dip, while one out of three tokens of both *beatha* [pe∼pɛ] 'life' and *faic* [fẽʰkʲ∼fɛ̃ʰkʲ] 'see' fall on the lax side of the dip. For S4, one out of three tokens of *geir* [kʲerʲ∼kʲɛrʲ] 'suet' and two out of three tokens of *lean* [Lʲen∼Lʲɛn] fall on the tense side of the dip.

[12]When the analysis was repeated using token means instead of midpoints (*see* fn. 7), F_{2norm} was significantly lower before /xk/ as well.

Figure 2.10: The distribution of tokens of short /a/ in normalised vowel space in retracting and non-retracting environments for each speaker

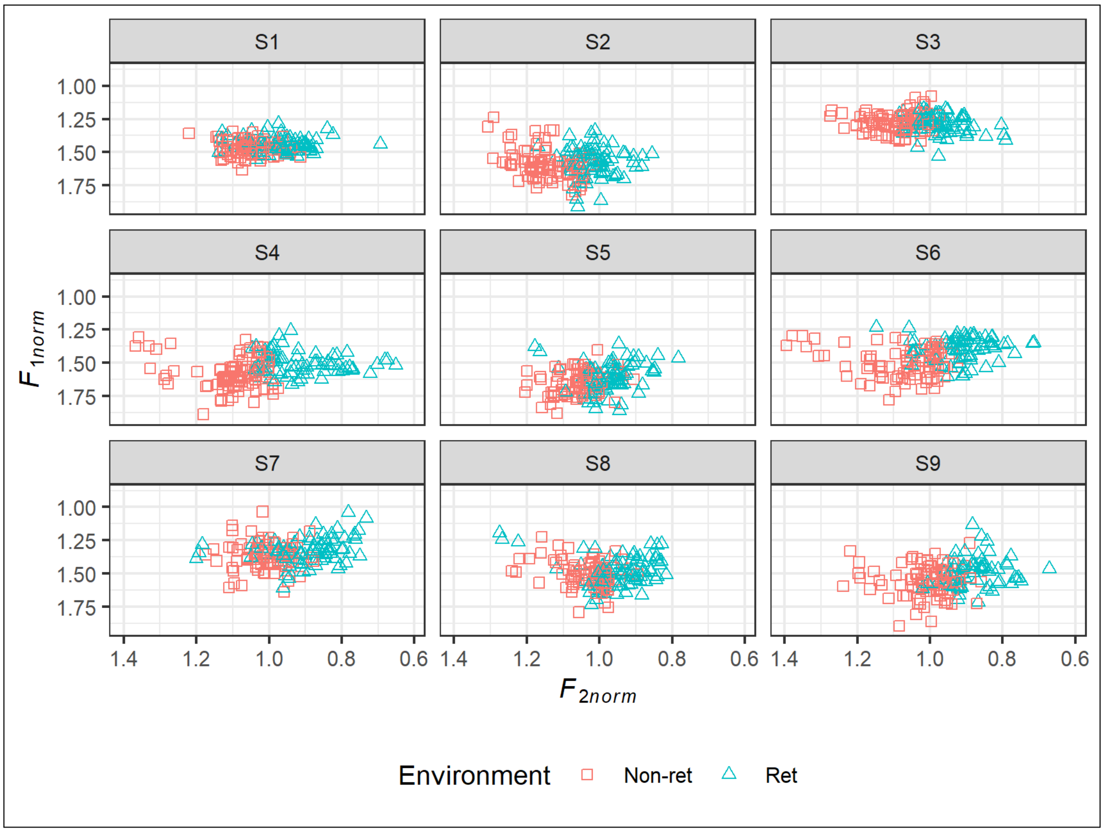


Table 2.10: LME model summary for F_{2norm} of short /a/ against environment

Fixed effects	Estimate	SE	df	t	p	
(Intercept)	1.07	0.016	17.11	67.13	$< .001$	***
Environment = Before /N/	−0.11	0.028	461.70	−3.83	$< .001$	***
Environment = Before /L/	−0.17	0.029	61.40	−5.86	$< .001$	***
Environment = After /L/	−0.20	0.032	46.83	−6.33	$< .001$	***
Environment = Before /R/	−0.090	0.029	60.75	−3.13	.003	**
Environment = After /R/	−0.13	0.028	61.31	−4.65	$< .001$	***
Environment = Before retroflex	−0.10	0.030	55.24	−3.44	.001	**
Environment = Before /xk/	−0.048	0.022	9.84	−2.21	.052	n.s.

have known this speaker to explicitly contrast the latter pair on other occasions,[13] while both pairs appear to be homophonous for S7 and S8. Given that this retraction, when it occurs, appears to be the sole locus of a phonological contrast, it is expected to be categorical. However, there is insufficient data to allow for systematic investigation of this specific environment.

The distribution of tokens of long /a:/ in normalised vowel space in retracting and non-retracting environments is shown for each speaker in Fig. 2.12, and F_{2norm}

[13]In fact, it was S1's correction of my own pronunciation of *seac* vs. *seachd* that originally brought my attention to this particular retraction process in the first place.

Figure 2.11: F_{2norm} of short /a/ in retracting and non-retracting environments for each speaker

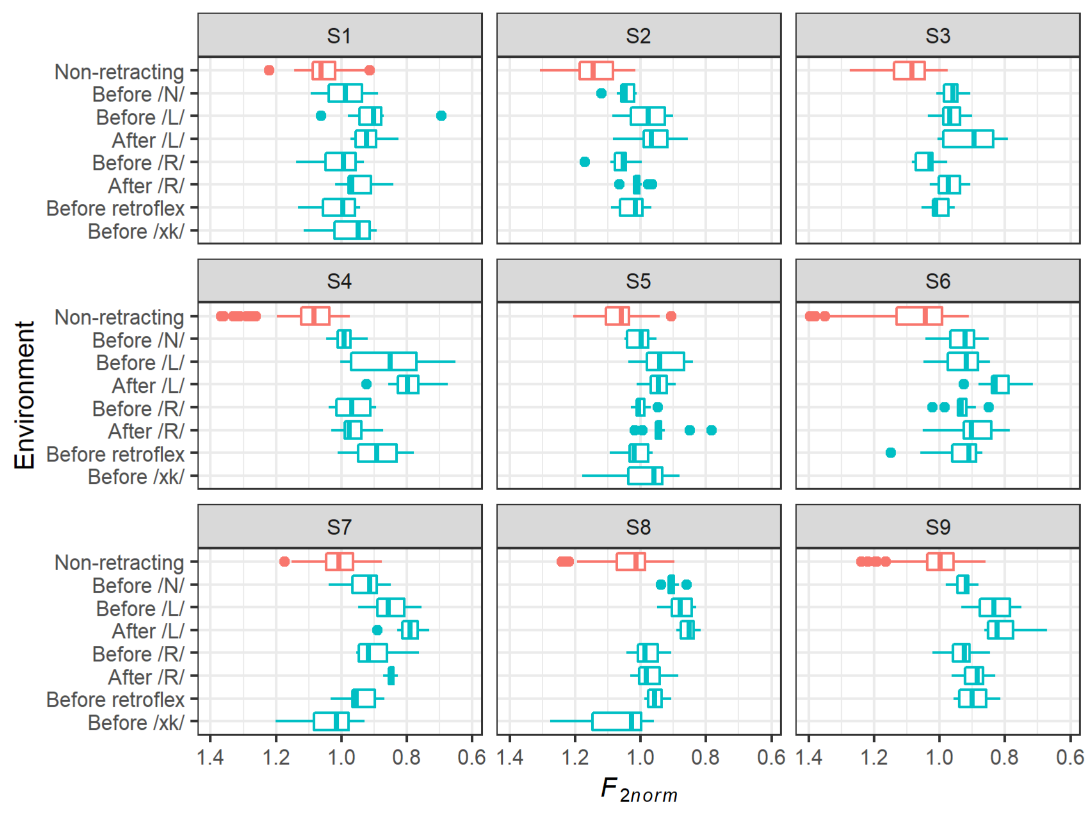


Table 2.11: LME model summary for F_{2norm} of long /aː/ against environment

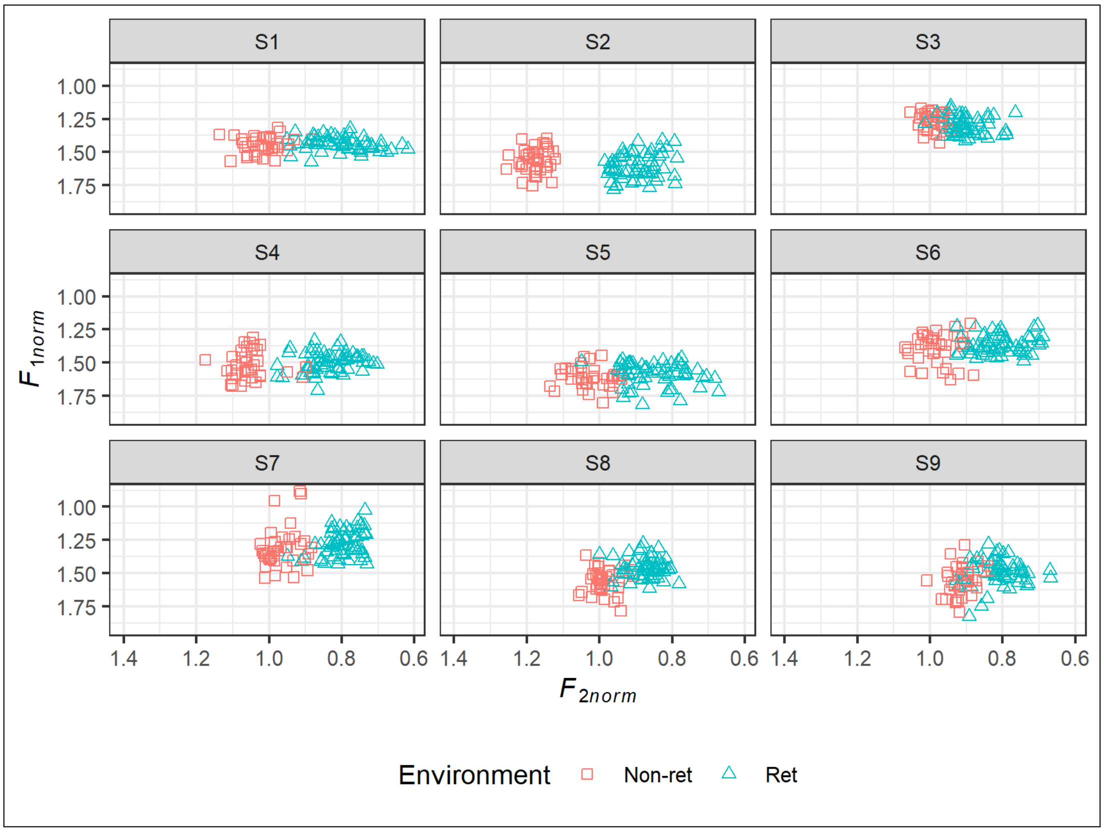
Fixed effects	**Estimate**	SE	df	t	p	
(Intercept)	1.01	0.024	10.29	41.84	$<.001$	***
Environment = Before /L/	-0.17	0.023	15.26	-7.24	$<.001$	***
Environment = After /L/	-0.22	0.030	13.05	-7.44	$<.001$	***
Environment = Before /R/	-0.16	0.020	21.37	-7.95	$<.001$	***
Environment = After /R/	-0.15	0.028	13.66	-5.44	$<.001$	***
Environment = Before retroflex	-0.15	0.023	14.81	-6.56	$<.001$	***

is shown in the boxplots in Fig. 2.13. Again, all speakers display a clear tendency for tokens in retracting environments to have lower F_{2norm} than those in non-retracting environments.

A similar LME model was fitted with F_{2norm} as the dependent variable and a fixed effect of environment (six levels: non-retracting, before /L/, after /L/, before /R/, after /R/, before retroflex). The model is summarised in Table 2.11. It can be seen that tokens of long /aː/ in every retracting environment display significantly lower F_{2norm} than those in non-retracting environments.

In order to search for evidence of categoricity in the distribution of retracted and

Figure 2.12: The distribution of tokens of long /aː/ in normalised vowel space in retracting and non-retracting environments for each speaker



non-retracted /a(ː)/, the density distributions of tokens of short /a/ and long /aː/ with respect to $F_{2_{norm}}$ in retracting and non-retracting environments are plotted in Figs. 2.14 and 2.15 respectively. While no clear bimodality can be seen in the distribution of short /a/ for any speaker, siblings S1, S2, and S7, as well as speaker S4, show clear visible signs of bimodality in the distribution of long /aː/.

Once again, Hartigan's Dip Test for multimodality was carried out in order to determine whether the presence of bimodality in the overall distribution of tokens of long /aː/ could be confirmed statistically for any of those four speakers. The results are shown in Table 2.12. As before, significance was assessed by means of the Holm-Bonferroni method. Speakers S2 and S4 display significant evidence of bimodality, meaning that at least those two individuals can therefore be said to display two phonological categories for long /aː/, but the apparent bimodality displayed by S1 and S7 cannot be confirmed statistically.

By once again taking the location of the dip as an estimate of the location of the boundary between the two (putative) categories for those speakers who display visible

Figure 2.13: F_{2norm} of long /a:/ in retracting and non-retracting environments for each speaker

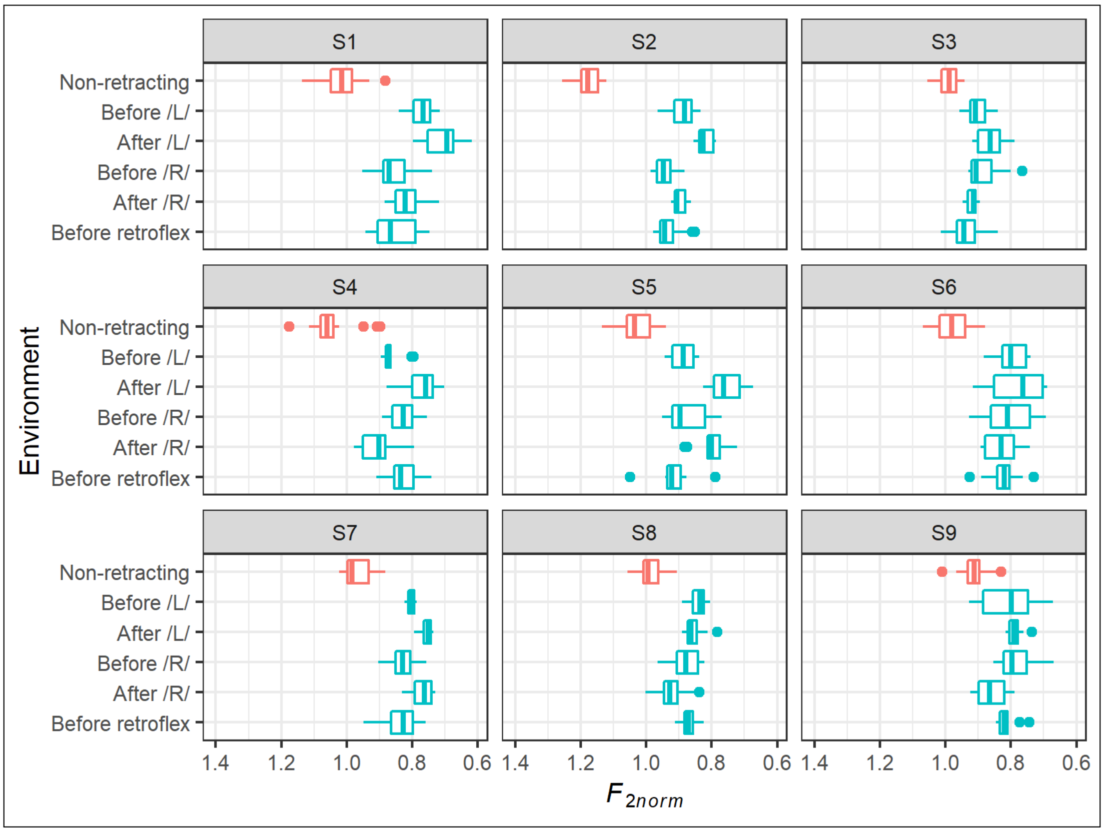


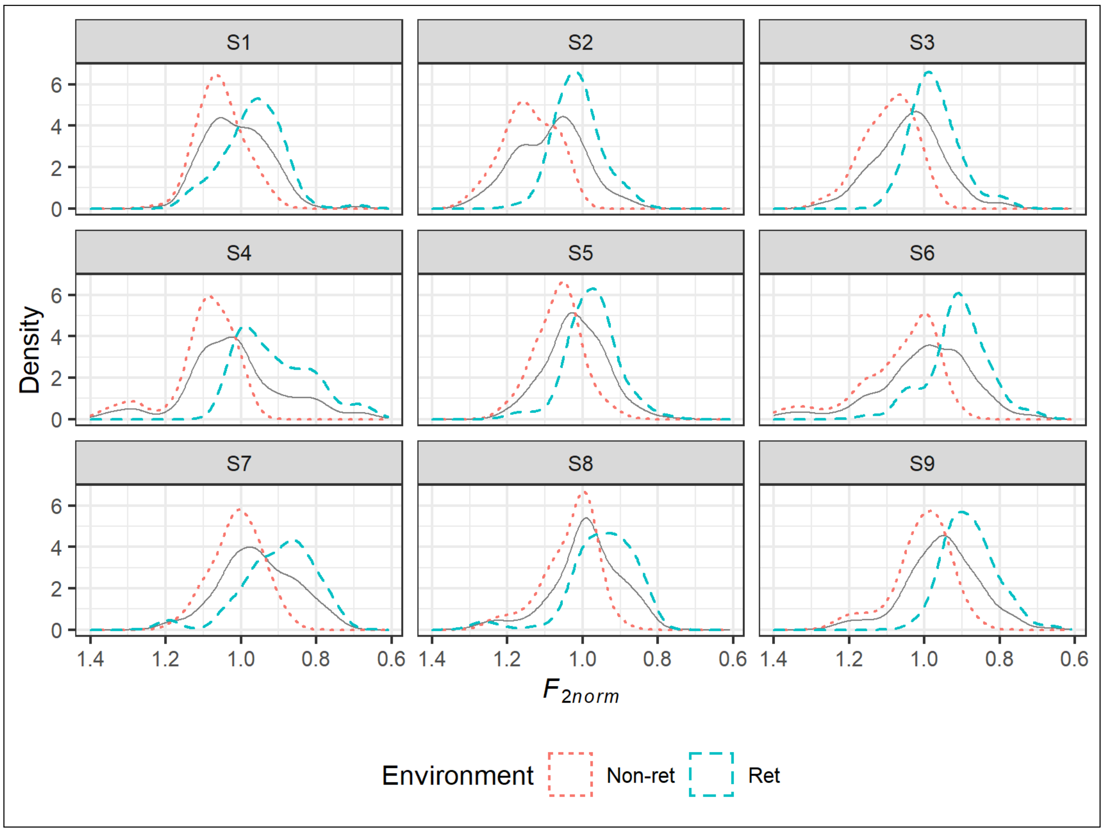
Table 2.12: Results of Hartigan's Dip Test for multimodality in those speakers who display visible signs of bimodality in F_{2norm} of long /a:/

Speaker	D	n	p	
S1	0.039	96	.344	n.s.
S2	0.11	99	$< .001$	***
S4	0.079	99	$< .001$	***
S7	0.052	97	.046	n.s.

evidence of bimodality, it was possible to establish whether individual words display the expected distribution according to the rule in (5). For all four speakers, the majority of tokens fall on the expected side of the dip. However, while S2 separates the two categories to a dramatic degree (*cf.* Fig. 2.12), several items display some inconsistency for S1, S4 and S7 and occasionally straddle the boundary between the two. In most cases, these are items with /a:/ before or after /R/ or before a retroflex, where retraction appears to be somewhat weaker than in other retracting environments.[14]

[14]It is difficult to determine for sure whether any of these speakers display the merger with /r/ reported by Nance & Ó Maolalaigh (2019). Since all speakers appear to display retraction in items coded with /R/, there are no (near-)minimal pairs in the data set where both rhotics can be compared in a similar vocalic context.

Figure 2.14: The density distribution of tokens of short /a/ with respect to F_{2norm} in retracting and non-retracting environments for each speaker. The solid grey curve represents the overall distribution.

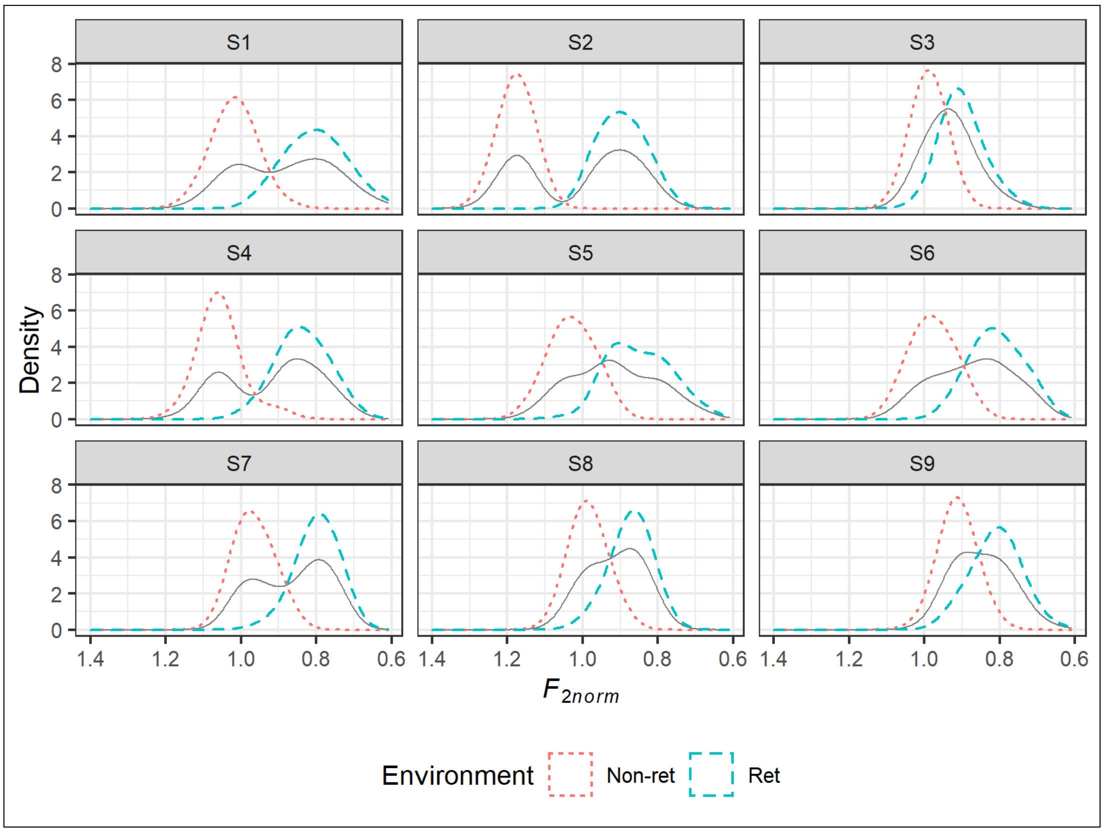


Sociolinguistic factors

Although the small number of speakers (nine) is unlikely to allow for any detailed sociolinguistic analysis, multiple linear regression analyses were carried out in order to determine whether any correlation could be found between sociolinguistic factors and the degree of laxing or retraction displayed by speakers. Four models were fitted, with the dependent variables (i) degree of *i*-laxing (speaker mean of T_i in Environment A − speaker mean of T_i in Environment B); (ii) degree of *e*-laxing (speaker mean of T_e in Environment A − speaker mean of T_e in Environment B); (iii) degree of retraction of short /a/ (speaker mean of F_{2norm} in non-retracting environments − speaker mean of F_{2norm} in retracting environments); (iv) the same again for long /aː/. In each case the three factors were gender (two levels: male, female), year of birth, and location of village of birth (two levels: southwestern Ness, northeastern Ness). None of the three factors achieved significance for any of the four dependent variables.

It is also possible to look for patterns with respect to whether or not a speaker

Figure 2.15: The density distribution of tokens of long /aː/ with respect to F_{2norm} in retracting and non-retracting environments for each speaker. The solid grey curve represents the overall distribution.



displays bimodality for a given allophonic process. Again there can be no detailed analysis, but it is worth noting that the only two speakers who show no visible evidence of bimodality in *i*-tenseness (S2 and S3) are the two oldest speakers in the sample, and that the only speaker who displays no bimodality for any of the four processes (S3) is the oldest. Note also that, of the four speakers who display visible evidence of bimodality in retraction of long /aː/, three (S1, S2 and S7) are the siblings from Adabrock.

2.4 Discussion

In this section I provide some general discussion of the results of the acoustic study described in §2.3, and consider the phonetic grounding of the various allophonic processes observed. Tense and lax /i e/ are discussed in §2.4.1, and the retraction of /a(ː)/ in §2.4.2.

2.4.1 Tense and lax /i e/

In accordance with the impressionistic observations detailed in §2.2, it is found in §2.3 that both /i/ and /e/ display significantly lower tenseness in Environment B than Environment A (as defined separately for the two vowels) when this is quantified using a combination of F_1 and F_2 values. However, speakers appear to vary with respect to the categoricity of the opposition. In the case of /i/, all but one of the nine speakers display visible signs of bimodality in the distribution of the tense and lax allophones, but this could be confirmed statistically for only one individual. It can therefore be concluded that at least some Ness Gaelic speakers display a categorical phonological opposition between tense and lax /i/, while for others the opposition may exist only at the gradient phonetic level. For the eight speakers for whom it is possible to establish a boundary between two (putative) categories, the majority of words display the expected allophone according to the rule in (3). Among those words that do display some inter-speaker variation, the distribution of the tense and lax allophones among speakers appears largely consistent with anecdotal evidence of microdialectal variation within Ness, with the lax allophone occurring more frequently at the northeast end of the district than the southwest end. However, without the use of a greater variety of stimuli it is not possible to be sure whether this variation is governed by a phonological rule or is in fact lexical: while it may be the case that speakers simply differ in the precise conditioning environments that govern the distribution of tense and lax /i/, it is also possible that the opposition has in fact undergone phonemicisation in some speakers and is thus no longer entirely rule-governed.

Turning now to /e/, six out of the nine speakers display visible signs of bimodality in the distribution of the tense and lax allophones, and this is confirmed statistically for three of those speakers. As with /i/, it can be concluded that at least some Ness Gaelic speakers display a categorical phonological opposition between tense and lax /e/, while for others the opposition may exist only at the gradient phonetic level. For the six speakers for whom it is possible to establish a boundary between two (putative) categories, the majority of words display the expected allophone according to the rule in (4). However, it is again not possible to be sure whether the variation that does occur is rule-governed or lexical, and it is possible that some speakers display a phonemic contrast similar to that found in other dialects (albeit with a different lexical distribution that largely conforms to this rule).

Due to the limitations of the available evidence, any interpretation in terms of diachronic change must inevitably be somewhat speculative. However, it is noted in §2.3.3 that the only two speakers who show no bimodality in *i*-tenseness are the two oldest speakers in the sample, and that the only speaker who displays no bimodality for any of of the processes investigated is the oldest. This might suggest that categoricity in at least some cases has begun to emerge only in the last few generations. This could explain the differences between my observations (speakers born 1943–84) and Borgstrøm's (1940, speakers probably born late 1800s) with respect to the laxing of /i e/, as well as the semi-consistent application of the rules in (3) and (4) in the chronologically intermediate *SGDS* data (Ness speaker born ca. 1922).

In terms of the *life cycle* of phonological processes (Bermúdez-Otero 2007; 2011: §3; 2015; Bermúdez-Otero & Trousdale 2012: §2), according to which the rules that govern sound patterns advance deeper into the grammar along predictable diachronic pathways, the rule determining the distribution of the two allophones would be said to have undergone *stabilisation* for a certain proportion of speakers in both cases. This refers to the diachronic stage at which a process formerly restricted to the gradient phonetic grammar is reanalysed by the learner, during intergenerational transmission, as part of the categorical phonology. In turn, gradient phonetic processes are assumed to ultimately originate from language-universal articulatory, auditory or perceptual biases that come to be encoded in speakers' phonetic grammars. This leads us to ask what phonetic biases may ultimately lie behind the particular distribution of tense and lax /i e/ in Ness Gaelic. For both /i/ and /e/, tenseness is conditioned by the immediately-following environment. Tense [i e] occur word-finally or before hiatus, /h/ or a pre-aspirated stop, and in the case of /i/ the tense allophone also occurs before the majority of slender consonants. Lax [ɪ ɛ] occur before all other consonants.

The occurrence of tense [i] before slender consonants can probably be attributed to simple co-articulation: the close front position of the tongue body during the production of this allophone serves to anticipate the palatal secondary articulation of the following consonant. Subordinate to this is the requirement that a tense vowel occur word-finally or before hiatus, /h/ or a pre-aspirated stop, and a lax vowel before all other consonants, and it is the phonetic grounding of this rule to which we will now turn.

A potential correlation between tenseness and duration was investigated in §2.3.3. While duration plays no role in the tenseness of /i/, it was found that there is a small but significant positive correlation between tenseness and duration for /e/. However, although shorter duration could increase the likelihood of undershoot and hence a more lax articulation, the small size of the effect and the fact that it is only detectable in /e/ mean that it is unlikely to be the cause of laxing.

Storme (2019) argues that the laxing of mid vowels in closed syllables in languages such as French is grounded in a trade-off between conflicting strategies of contrast enhancement in vowels and consonants. Largely due to their higher F_1, lax vowels allow for more distinctive formant transitions at the VC boundary than tense vowels, so laxing can enhance perceptual cues to the place of articulation of a following consonant. This is supported experimentally by Lisker (1999), who finds that English voiceless stops with no audible release burst are correctly identified more frequently after lax or open monophthongs than after tense non-open monophthongs or closing diphthongs. Because coda consonants tend to lack other strong cues to place of articulation, closed-syllable laxing in languages such as French may serve to enhance the perceptual distinctiveness of coda consonants. On the other hand, when there is no following coda consonant in need of such enhancement, vowels are tense by default as this maximises their own perceptual distinctiveness.

Although laxing in Ness Gaelic occurs not only before coda consonants but before onset consonants as well,[15] it is noteworthy that the environments in which lax [ɪ ɛ] occur are precisely those environments in which there is a direct transition between the stressed vowel and a following supra-glottal consonant. Apart from the overriding requirement that /i/ be tense before the majority of slender consonants, /i e/ are lax before all supra-glottal consonants except for pre-aspirated stops. The environments in which they are tense are (i) word-finally, where no consonant follows; (ii) before hiatus, where again no consonant follows; (iii) before /h/, which has no oral place

[15] I adopt the widespread view that intervocalic consonants are universally syllabified as onsets rather than codas, i.e. V.CV. Note that Borgstrøm (1937; 1940; 1941) describes VC.V syllabification as characteristic of *Class 1* forms in Scottish Gaelic (*see* ch. 4), a claim repeated in a few other accounts (Holmer 1957, 1962, Dilworth 1972, *see* Bosch 1998 for a detailed review). Borgstrøm bases this assertion entirely on his perception of a "break in tension" towards the end of the consonant, which he interprets as the phonetic manifestation of a syllable boundary but which most probably just represents glottalisation. That analysis has no phonological basis and is incompatible with modern conceptions of the syllable.

of articulation; and (iv) before a pre-aspirated stop, where a period of [h]-like glottal frication intervenes between the vowel and the stop closure. The lax allophone therefore occurs if and only if there is the potential for formant transitions to contribute to the perceptual distinctiveness of a following consonant.

I therefore propose a generalised version of Storme's (2019) analysis, hypothesising that laxing may potentially serve to enhance the perceptual distinctiveness of not only coda consonants but any immediately-following consonant. Languages vary with respect to the lengths they will go to in order to enhance consonantal contrasts in this way. While languages with closed-syllable laxing, such as French, are willing to sacrifice some of the perceptual distinctiveness of a vowel only as a last resort, i.e. for the benefit of a perceptually vulnerable coda consonant, it may be the case that Ness Gaelic reaches a different trade-off, favouring the consonant even when it is not in the coda. If this is true, it would be consistent with a far more general trend in the development of the Goidelic languages whereby vocalic distinctions are frequently overridden in order to enhance contrasts in adjacent consonants. This is seen, for instance, in the backing or breaking of original front vowels before certain broad consonants in Scottish Gaelic, e.g. *geal* [kʲɑL] 'white', *sìos* [ʃiəs] 'down' (Early Irish *gel* [gʲel], *sís* [ʃiːs]), or the development of an alleged vertical system of short vowels in Irish (Ó Siadhail & Wigger 1975; Ó Siadhail 1989; Ní Chiosáin 1991).

Ideally, a perceptual study would help to establish whether laxing indeed serves to enhance the perceptual distinctiveness of a following consonant in Ness Gaelic. Unfortunately, this lies outwith the scope of the present paper and must remain a potential point of future research.

2.4.2 Retraction of /a(ː)/

Again in accordance with the auditory observations detailed in §2.2, it is found that, relative to non-retracting environments, long and short /a(ː)/ display significantly lower F_2 in all retracting environments except before /xk/. In the case of short /a/, no speaker shows any evidence of bimodality in the distribution of the retracted and non-retracted allophones, so it can be concluded that this retraction probably occurs only at the gradient phonetic level. However, four out of the nine speakers display visible signs of bimodality in the distribution of retracted and non-retracted long /aː/,

and this is confirmed statistically for two of those speakers, so it can be concluded that this is a categorical phonological opposition for at least some Ness Gaelic speakers.

As with tense and lax /i e/, the retraction of long /aː/ can be said to have undergone stabilisation for a certain proportion of speakers. However, the retraction of short /a/ appears to still be at pre-stabilisation stage of the life cycle, displaying no sign of having entered the categorical phonology for any speakers. The phonetic grounding of retraction next to velarised consonants can probably be attributed to coarticulation, since velarisation itself involves retraction of the tongue body. However, the occasional retraction of /a/ before [ʰk] when this represents underlying /xk/ is less clear, since retraction does not generally occur next to consonants with velar primary articulation. This instead appears to represent a more complex process of transphonologisation, whereby the velar consonant /x/ is compensated for, in the event of its loss, by retraction of the vowel in order to preserve the underlying contrast. It is interesting to note, however, that /x/ does pattern with the velarised consonants with respect to some other interactions with vowels. Recall from ch. 1, §1.2.2 that it triggers retraction of short /u/ in Lewis, and note also that, at a deeper phonological level, /x/ in the Ness dialect joins the velarised consonants in enforcing preceding /a/ where other dialects have /ɛ/, e.g. *neach* [Nʲãx] 'person' in Ness vs. [Nʲɛ̃x] elsewhere (*see* ch. 5, §5.5.1).

2.5 Conclusion

The vowel system of present-day Ness Gaelic differs in several important respects from the system normally reported for Lewis Gaelic and for Scottish Gaelic dialects in general. As discussed in §2.2, short /ɯ/ and long /ɛː/ do not occur. Additionally, short /i/ displays a lax allophone [ɪ] in certain consonantal environments, and short [e ɛ] are in complementary distribution according to a similar rule to that governing the distribution of tense and lax /i/. Finally, both short and long /a(ː)/ display a retracted allophone [ɑ(ː)] next to velarised consonants. This study documents these aspects of the Ness dialect, some of which have not been reported in the existing literature, and in §2.3 provides the first instrumental examination of these allophonic patterns.

It is shown that speakers vary with respect to whether these processes belong to the gradient phonetics or the categorical phonology. In terms of the *life cycle* of phonological processes, individual speakers are said in §2.4 to lie at different points along the diachronic pathway by which gradient phonetic processes are reanalysed as belonging to the phonological grammar. Following Storme (2019), it is proposed in §2.4 that the distribution of tense and lax /i e/ is grounded in competing strategies of contrast enhancement, whereby vowels undergo laxing in order to maximise the perceptual distinctiveness of a following consonant. Finally, from a more general perspective, this paper provides vital documentation of a unique dialect of a language undergoing rapid decline.

Chapter 3

Phonetic and phonological patterns of vowel nasalisation

3.1 Introduction

Since the 1980s, a large number of studies have uncovered subtle, gradient phonetic differences between segments long thought to be subject to phonological neutralisation.[1] Alongside similarly gradient effects of usage factors such as lexical frequency (Bybee 2001; Pierrehumbert 2002), this *incomplete neutralisation* poses a challenge to strictly modular feedforward architectures of grammar in which the phonetics is sensitive only to the discrete, categorical output of the phonology, and may be taken as evidence for models in which the phonetics has access to morphological and/or lexical information (Steriade 2000; Ernestus & Baayen 2006; 2007; Kleber et al. 2010; Winter & Röttger 2011; Braver 2013; 2019; Roettger et al. 2014). However, the existing literature on incomplete neutralisation is heavily biased towards a small selection of typologically common morphophonological processes – particularly final devoicing – while far less work exists on more unusual phenomena such as the *initial mutations* that occur in the Celtic languages.

In this paper I explore the question of whether incomplete neutralisation can be observed in connection with the alternations that occur under initial mutation. I show that the small body of existing work on the topic has so far failed to turn up any

[1] This chapter is based on a post-peer-review, pre-copyedit version of an article published in *Morphology* as Morrison (2020) (doi: `https://doi.org/10.1007/s11525-020-09347-5`).

convincing evidence for incomplete neutralisation in initial mutation, and I present a new study on Scottish Gaelic with negative results. By identifying categorical and gradient patterns of nasal airflow in four speakers from Lewis, I demonstrate that only phonological nasalisation – and not phonetic nasalisation – may display morphological conditioning. These results provide further evidence that initial mutation does not bring about incomplete neutralisation, and are consistent with recent claims by Hall (2017) and Seyfarth et al. (2019) regarding the kinds of morphophonological alternations with which incomplete neutralisation can and cannot occur.

The structure of the paper is as follows. §3.2 provides background information on incomplete neutralisation, initial mutation and vowel nasalisation in Scottish Gaelic, and §3.3 reports on an experiment that explores whether initial mutation in Scottish Gaelic brings about incomplete neutralisation. §3.4 provides some general discussion and §3.5 concludes the paper.

3.2 Background

In this section I provide background information on the topics with which this paper is concerned. §3.2.1 discusses incomplete neutralisation and phonetic paradigm uniformity effects and shows how they are problematic for a modular feedforward architecture of grammar. §3.2.2 introduces the reader to the initial mutations of the Celtic languages and provides a detailed review of the existing literature on incomplete neutralisation in initial mutation. §3.2.3 discusses phonological and phonetic patterns of vowel nasalisation in Scottish Gaelic, and the manner in which vowel nasalisation interacts with a neutralising process triggered by an initial mutation.

3.2.1 Incomplete neutralisation and phonetic paradigm uniformity effects

Morphological paradigms often involve neutralisation, where a phonological contrast that is observable in one part of the paradigm is not realised in another. For instance, in German, the contrast between voiced and voiceless obstruents is neutralised word-finally as a result of final devoicing:

(1) *Rad* /ʀaːd/ [ʀaːt] ‘wheel’ *cf.* GEN *Rades* /ʀaːd-əs/ [ʀaːdəs]

Rat /ʀaːt/ [ʀaːt] 'advice' GEN *Rates* /ʀaːt-əs/ [ʀaːtəs]

However, many studies have found that the neutralisation brought about by final devoicing is incomplete. Acoustically, this *incomplete neutralisation* typically manifests itself in the partial retention by devoiced consonants of certain properties normally associated with voiced consonants, such as shorter closure duration or longer preceding vowel duration. As well as for German (Mitleb 1981; Fourakis & Iverson 1984; Charles-Luce 1985; Port & O'Dell 1985; Port & Crawford 1989; Piroth & Janker 2004), acoustic evidence of incomplete neutralisation in final devoicing has been reported for Catalan (Dinnsen & Charles-Luce 1984; Charles-Luce & Dinnsen 1987), Polish (Slowiaczek & Dinnsen 1985; Tieszen 1997), Russian (Barry 1988; Dmitrieva et al. 2010; Kulikov 2012; Kharlamov 2012; 2014; Shrager 2012), Afrikaans (van Rooy et al. 2003; Kaplan 2017), Dutch (Warner et al. 2004) and Bulgarian (Bishop et al. 2019). It has also been found that listeners perform at above-chance level when attempting to discriminate between minimal pairs that differ only in underlying voicing in German (Port et al. 1984; Port & O'Dell 1985; Port & Crawford 1989), Polish (Slowiaczek & Szymanska 1989), Afrikaans (van Rooy et al. 2003) and Russian (Matsui 2011; Kharlamov 2012; 2015). Besides final devoicing, incomplete neutralisation has also been reported in connection with various other phenomena, such as American English *t/d*-flapping (Fisher & Hirsh 1976; Fox & Terbeek 1977; Zue & Laferriere 1979; Patterson & Connine 2001; Herd et al. 2010; Braver 2011; 2013; 2014) and Russian unstressed vowel reduction (Padgett & Tabain 2005; Kaplan 2017).

Although statistically significant across large numbers of tokens, the differences between incompletely neutralised segments are small, gradient and not readily perceptible, and may generally be detected only through experimentation and statistical analysis. Under a traditional view of phonology as operating upon discrete symbolic representations, they therefore cannot be comfortably assigned to distinct phonological categories, which is problematic for a strictly modular feedforward architecture of grammar in which the phonetics is sensitive only to the categorical output of the phonology. Nevertheless, it has been suggested that incompletely neutralised segments do in fact have distinct phonological surface representations, rendering the phenomenon compatible with such a framework. Van Oostendorp (2008) argues that a devoiced segment continues to bear an unpronounced [voice] feature which may subtly influence its phonetic interpretation, while Iosad (2017: 22–24) considers incomplete neutralisation to occur when fully distinct phonological representations are assigned ranges of phonetic realisations that happen to almost entirely overlap. However, if the phonetics is sufficiently powerful to bring about such near-complete neutralisation of a categorical phonological contrast, then this raises the question of whether a separate categorical phonology is necessary at all.

Because incompletely neutralised forms display subtle traces of the properties of paradigmatically related forms, incomplete neutralisation may be regarded as a type of *paradigm uniformity effect*. Paradigm uniformity effects at the level of categorical phonology are well-known. For instance, English post-nasal coda *g*-deletion overapplies in *singer* /sɪNg-ə/ [sɪŋə] (*cf. finger* /fɪNgə/ [fɪŋgə]) as a result of its paradigmatic relationship with *sing* /sɪNg/ [sɪŋ], in which deletion applies transparently. Under a modular architecture this can be handled either by means of *cyclicity see* ch. 1 §1.1, whereby the deletion rule belongs to the stem-level phonology and thus applies before suffixation takes place, or by *output-output* (OO-)*correspondence* (Kenstowicz 1996; Benua 1997), in which high-ranked OO-correspondence constraints enforce phonological identity between corresponding morphemes in paradigmatically related forms. Regardless of which approach is correct, paradigm uniformity effects at the level of categorical phonology are unproblematic for a modular feedforward architecture. Note that the term *incomplete neutralisation* is therefore not appropriate for cases where the observed difference is sufficiently large, categorical and readily perceptible to constitute an ordinary phonological contrast – for example, in Friulian final devoicing, vowels before underlyingly voiced stops may be over twice as long as those before underlyingly voiceless ones (Baroni & Vanelli 2000). In this case, neutralisation clearly does not occur in the first place and the surface contrast can be considered straightforwardly phonological.

Unlike those at the level of categorical phonology, paradigm uniformity effects at the level of gradient phonetics can be used to argue for non-modular frameworks in which the phonetics has direct access to morphological and/or lexical information. Steriade (2000) and Braver (2013; 2019) argue that OO-correspondence constraints may make reference to phonetic properties, thus motivating identity between paradigmatically related forms at the level of fine-grained phonetic detail. Regarding incomplete neutralisation in final devoicing, Ernestus & Baayen (2006; 2007), Kleber et al. (2010), Winter & Röttger (2011) and Roettger et al. (2014) favour an exemplar-based approach in which both inflected and uninflected forms are stored together in a phonetically rich lexicon and the production of one form may be subtly influenced by partial co-activation of paradigmatically related forms. Both of these approaches are inherently non-modular, as they discard the traditional distinction between categorical phonology and gradient phonetics.

The overwhelming majority of work on incomplete neutralisation has focused on Indo-European languages and the straightforwardly concatenative morphology that is common throughout that family – notable exceptions include Peng (2000) and Yu (2007), who look at the neutralisation of tonal contrasts in Chinese languages, and Gouskova & Hall (2009) and Hall (2013; 2017), who investigate neutralising processes affecting vowels in a variety of Arabic. It is therefore likely that we do not yet have a complete picture of the types of processes that may bring about incomplete neutralisation. In particular, very little work exists on the Celtic languages, which – although they belong to Indo-European – display a typologically unusual type of morphophonological alternation known as *initial mutation*. While final devoicing is a highly transparent and phonetically natural process that serves to satisfy a phonotactic constraint, the alternations that occur in connection with initial mutation are different in nature, being directly triggered by the morphology itself. It is therefore far from clear that initial mutation should be subject to the same kinds of paradigmatic effects as have been observed in better-studied alternations. This study investigates an initial mutation in Scottish Gaelic in order to determine whether it brings about complete or incomplete neutralisation.

3.2.2 Initial mutation

All of the living Celtic languages are characterised by systems of morphophonological alternations in initial consonants known as *initial mutations*. *Radical* (unmutated) consonants are replaced by their mutated counterparts under a variety of conditions. For example, possessive particles in Irish and Welsh trigger a variety of mutations on a following noun:

(2) a. **Irish**

a cat	[ə kʊt̪ˠ]	‘her cat’	(radical)
a chat	[ə xʊt̪ˠ]	‘his cat’	(lenition)
a gcat	[ə gʊt̪ˠ]	‘their cat’	(eclipsis)

b. **Welsh**

eu cath	[i ka:θ]	‘their cat’	(radical)
ei gath	[i ga:θ]	‘his cat’	(soft mutation)
fy nghath	[və ŋ̊a:θ]	‘my cat’	(nasal mutation)
ei chath	[i xa:θ]	‘her cat’	(aspirate mutation)

In Irish, radical initial /k/ undergoes frication to [x] under *lenition* and voicing to [g] under *eclipsis*. Meanwhile, in Welsh, radical initial /k/ undergoes voicing to [g] under the *soft mutation*, nasalisation to [ŋ̊] under the *nasal mutation* and frication to [x] under the *aspirate mutation*. An extensive literature exists on the analysis of the initial mutations and their exact place in the grammar (*see* references in ch. 5, §5.2.2). Importantly, initial mutation differs from the straightforwardly concatenative morphology that is common throughout Indo-European in that it appears to involve the substitution of one segment for another, although authors such as Lieber (1983; 1987), Wolf (2007) and Iosad (2014; 2017) offer accounts in which the relevant alternations are triggered by the affixation of featural autosegments such as [+continuant], [−spread glottis] or [+nasal]. While the examples in (2) contain an overt local trigger, initial mutations can also display purely morphological conditioning: for example, lenition in Irish marks past tense on verbs and feminine agreement on attributive adjectives. Throughout this paper, I will therefore assume that a set of forms such as Irish [kʊt̪ˠ]∼[xʊt̪ˠ]∼[gʊt̪ˠ] or Welsh [ka:θ]∼[ga:θ]∼[ŋ̊a:θ]∼[xa:θ] make up a morphological paradigm and are thus comparable to sets like German [ʀa:t]∼[ʀa:dəs].

Initial mutation very often brings about neutralisation. In some cases, a particular segment may occur both as radical initial and also as the mutated grade of a different radical initial: for example, initial [bˠ d̪ˠ g] in Irish may represent either radical /bˠ d̪ˠ g/ or the eclipsis grade of radical /pˠ t̪ˠ k/. In other cases, a particular segment may occur as the mutated grade of more than one radical initial: for example, initial [v] in Welsh represents the soft mutation grade of both radical /b/ and radical /m/. A small number of recent studies have investigated whether neutralisations such as these are incomplete, with no convincing positive results. Archangeli et al. (2014) report preliminary results, from three speakers, of an ultrasound study of the articulation of lenited consonants in Scottish Gaelic. The authors compare the position of the tongue body during the articulation of various neutralised consonants, such as [h] from lenition of /t̪ʰ/ (e.g. *thachd* [haxk] 'choke', radical *tachd* [t̪ʰaxk]) vs. [h] from lenition of /s/ (e.g. *shad* [hat̪] 'toss', radical *sad* [sat̪]) vs. non-alternating [h] (e.g. *tha* [haː] 'be.PRS'). Although they do report some incomplete neutralisation, the items that they compare are poorly matched for following environment. All of the target consonants are either dorsal or glottal, meaning that the position of the tongue body during their articulation will be highly sensitive to anticipatory co-articulation with the following vowel. In a pair such as *thachd* [haxk] 'choke' (radical *tachd* [t̪ʰaxk]) vs. *shad* [hat̪] 'toss' (radical *sad* [sat̪]), for instance, it is likely that the differing place of articulation of the following consonant results in a slight difference in the articulation of the vowel, which in turn will be reflected in the position of the tongue body during [h]. Some pairs involve a short vowel vs. a long vowel, e.g. *dhiubh* [ju] 'of them' (non-alternating) vs. *ghiùlain* [juːLaNʲ] 'behave' (radical *giùlain* [kʲuːLaNʲ]), or a short vowel vs. the first element of a diphthong, e.g. *ghabh* [ɣav] 'take' (radical *gabh* [kav]) vs. *dhall* [ɣauL] 'blind' (radical *dall* [t̪auL]), where an exact match in quality is not necessarily to be expected in the first place. Additionally, one of the three speakers is from Lewis, where it is well documented that /u(ː)/ displays a highly distinct retracted allophone next to velarised consonants such as /L/ (Borgstrøm 1940: 32–33; Oftedal 1956: 75; Ladefoged et al. 1998; Nance 2011), and *gabh*∼*ghabh* is normally pronounced [kɔ]∼[ɣɔ], potentially rendering these pairs very poorly matched for this speaker in particular. I therefore do not consider these results to be convincing evidence for incomplete neutralisation.

As part of a broader psycholinguistic study, Ussishkin et al. (2017) investigate whether speakers of Scottish Gaelic are able to discriminate between [f$^{(j)}$] from lenition of /p$^{(j)}$/ (e.g. *phioc* [fʲoxk] 'pick', radical *pioc* [pʲʰoxk]) and [f$^{(j)}$] representing radical /f$^{(j)}$/ (e.g. *feòrag* [fʲoːrak] 'squirrel'). No statistically significant effect is found.

Welby et al. (2017; *see also* 2011; 2014) investigate whether Irish [bˠ g] from eclipsis of /pˠ k/ (e.g. *gcasúr* [gasˠuːrˠ] 'hammer', radical *casúr* [kasˠuːrˠ]) differ acoustically from [bˠ g] representing radical /bˠ g/ (e.g. *gadaí* [gad̪ˠiː] 'robber'). No statistically significant effect is found for VOT, consonant duration or closure duration, but the average intensity of the stop burst is found to be significantly greater for [bˠ g] from eclipsis of /pˠ k/ than for [bˠ g] representing radical /bˠ g/. However, as acknowledged by the authors themselves, this study encounters a serious problem. All of the target items are nouns immediately preceded by the definite article *an* [ə(n̪ˠ)], which may be realised with or without [n̪ˠ]. In the eclipsis items, eclipsis is triggered by the presence of a preposition (e.g. *ar an gcasúr* [ɛrʲ ə(n̪ˠ) gasˠuːrˠ] 'on the hammer'), while no preposition is present in the radical items (e.g. *an gadaí* [ə(n̪ˠ) gad̪ˠiː] 'the robber'). Unexpectedly, it is found that the [n̪ˠ]-less variant of the article occurs far more frequently after prepositions than when no preposition is present. Because the authors were unable to control for this, any difference in average burst intensity between eclipsis voiced stops in e.g. *ar an gcasúr* and radical voiced stops in e.g. *an gadaí* is likely to be due to the fact that the stop is preceded by [n̪ˠ] far more frequently in the radical context than in the eclipsis context.

Venturing outwith Celtic, some Austronesian languages display a morphophonological process known as *nasal substitution*, which resembles the initial mutations of the Celtic languages. In an ultrasound study of Javanese and Sasak, Archangeli et al. (2017) compare the articulation of nasal [ɲ] from radical /s/ to that of nasal [ɲ] from radical /tɕ/, while Seyfarth et al. (2019) investigate whether Javanese [m ŋ] from radical /p k/ differ acoustically from non-alternating [m ŋ]. No statistically significant effect is found in either case.

Welby et al. (2017: 131–132) also cite two cases from the existing descriptive literature of what they refer to as "incomplete neutralisation" in initial mutation. First of all, Falc'hun (1951) reports for the Bas-Léon dialect of Breton that [b_1 d_1 g_1] representing radical /b d g/ (e.g. *dour* [d_1uːr] 'water') are longer and have stronger release bursts than [b_2 d_2 g_2] from lenition of /p t k/ (e.g. *dour* [d_2uːr] 'tower', radical *tour* [tuːr]). However, what Falc'hun is describing here is part of a phonological contrast between *fortis* and *lenis* consonants that pervades almost the entire consonant system of the dialect in question, whereby all radical initial consonants are fortis and are thus considerably longer and more strongly articulated than the lenis consonants that result from lenition (*see also* Falc'hun 1943: 43–44; Kervella 1947; Hamp 1951; Carlyle 1988). The distinction is readily perceptible to native speakers and it appears unlikely that phonological neutralisation is involved in the first place. In any case, the difference is in the opposite direction to what would be expected under incomplete neutralisation.[2] Secondly, Borgstrøm (1940) and Oftedal (1956) report for the Lewis dialect of Scottish Gaelic that [m_1 N_1 $N^j{}_1$] representing radical /m N Nʲ/ (e.g. *mara* [$m_1$arə] 'sea.GEN') are fully nasal while [m_2 N_2 $N^j{}_2$] from "nasalisation" of /p t̪ tʲ/ (e.g. *am bara* [ə $m_2$arə] 'the wheelbarrow', radical *bara* [parə] 'wheelbarrow') are post-stopped. However, given that the distinction is so great as to be readily perceptible by fieldworkers, it is again unlikely that phonological neutralisation is involved. It is also somewhat doubtful that this process in Scottish Gaelic should be regarded as part of the initial mutation system, rather than as a purely phonological process of sandhi between a floating nasal consonant and a following word-initial stop (*see* ch. 5, §5.2.3). There is therefore no convincing evidence so far for incomplete neutralisation in initial mutation.

3.2.3 Vowel nasalisation in Scottish Gaelic

The primary focus of this study is the interaction of vowel nasalisation with an initial mutation in Scottish Gaelic. During the production of a nasalised vowel, the velum is lowered as for a nasal consonant and a proportion of the pulmonic egressive airstream is allowed to escape through the nasal cavity rather than through the mouth. Nasalisation may be measured experimentally in a number of ways, some more invasive or impractical than others (*see* Krakow & Huffman 1993 for a detailed discussion of early methods). Krakow (1989; 1993) measures the degree of opening of the velopharyngeal port using the *Velotrace*, a mechanical device that is inserted through the nose and directly records the position of the velum (Horiguchi & Bell-Berti 1987), while Solé (1992; 1995) employs a *nasograph*, a photoelectric device inserted through the nose and into the oesophagus (Ohala 1971). More recently, real-time magnetic resonance imaging has been used to directly observe velic and other articulatory movements during the production of nasalised vowels (Byrd et al. 2009; Proctor et al. 2013; Carignan et al. 2015; Barlaz et al. 2018; Johnson et al. 2019). It is also possible to measure nasalisation acoustically by spectral analysis (e.g. Chen 1996; 1997; Beddor 2007;

[2] *Contra* Welby et al. (2017), who erroneously state that it is the voiced stops derived from lenition of voiceless stops that are longer and have stronger release bursts, which is the opposite of what Falc'hun (1951) reports.

Carignan et al. 2011; Shosted et al. 2012; Li 2014; Zellou & Tamminga 2014; Scarborough et al. 2015; Cho et al. 2017; Seyfarth et al. 2019), although the effect of nasalisation on formant values is often complex. An uninvasive, highly practical technique involves measuring the rate of nasal airflow at the nostrils in order to obtain an indirect measure of velic opening (e.g. Cohn 1990; 1993; Huffman 1990; Jun 1993; Basset et al. 2001; Shosted 2006; 2007; Delvaux et al. 2008; Carignan et al. 2011; Shosted et al. 2012; Carignan 2013; Li 2014; Warner et al. 2015; Desmeules-Trudel & Brunelle 2018). This is the technique employed in this study.

The issue of nasalisation in Scottish Gaelic has previously been investigated in a nasal airflow study by Warner et al. (2015). A nasalised fricative [ṽ], and occasionally other nasalised fricatives, have been claimed to occur in Scottish Gaelic (e.g. Ternes 1973: 134 ff.; MacAulay 1992b: 227; Ó Maolalaigh 2003: 120), but the authors conclude that true nasalised (non-glottal) fricatives are virtually non-existent in Scottish Gaelic. The present study, however, is concerned with the nasalisation of vowels. Vowel nasalisation in Scottish Gaelic is a fairly complex issue. Stressed vowels may occasionally be phonemically nasalised – recall from §1.2.3 that stress usually falls on the initial syllable, so it is the initial syllable that we are concerned with in all forms cited in this paper:

(3)	*amhaich*	[ãfixʲ]	'neck'	*faic*	[fẽʰkʲ]	'see'
	cnoc	[kʰrõʰk]	'hill'	*grànda*	[krãːt̪ə]	'ugly'
	cumhang	[kʰʉ̃.ək]	'narrow'	*làmh*	[Lɑ̃ːv]	'hand'
	dannsa	[t̪ãʉ̃s]	'dance'	*langa*	[Lɑ̃ɣə]	'ling'

Additionally, Borgstrøm reports for Barra (1937: 78–79) and Bernera, Lewis (1940: 13) that all vowels are "more or less" nasalised when adjacent to nasal consonants. However, this is disputed by Oftedal (1956: 40) for Leurbost, Lewis, Ternes (1973: 126–127) for Applecross, Ross-shire, Dorian (1978: 57) for East Sutherland, and Wentworth (2005: 52) for Gairloch, Ross-shire, all of whom find that nasalisation may be contrastive on stressed vowels even next to nasal consonants. Ternes – who is also acquainted with the dialects of Barra and Lewis – concludes that Borgstrøm's account is simply incorrect, and this is further supported by my own fieldwork in Ness in Lewis. Although stressed vowels are usually strongly nasalised when preceded by a nasal consonant, there are a number of items with preceding [m] in which this fails to occur:

(4) a. Nasalised vowel

madainn	[mãt̪iNʲ]	‘morning’	*meur*	[mĩãr]	‘finger’
màthair	[mãːhərʲ]	‘mother’	*mias*	[mĩə̃s]	‘basin’

b. Non-nasalised vowel

marag	[marak]	‘pudding’	*morghan*	[mɔrɔɣan]	‘gravel’
marbhadh	[mara.əɣ]	‘kill.VN’	*muilinn*	[mʉlʲiNʲ]	‘mill’

In the systems described by Oftedal (1956), Ternes (1973), Dorian (1978) and Wentworth (2005), the same contrast may potentially occur after other nasal consonants, as well as before a following nasal consonant. However, this study will consider only vowels preceded by [m], which is the only one of these environments where I am certain that such a contrast exists in Ness.

There is no rule to determine when nasalisation will fail to occur after a nasal consonant. Oftedal (1956: 42) notes a tendency for nasalisation to be blocked on vowels adjacent to rhotic consonants or in svarabhakti groups (stressed VCV sequences that are phonologically monosyllabic; *see* ch. 4), but plenty of counterexamples exist. Because nasalisation of a vowel after a nasal consonant appears to be the default case, I will assume in this paper that a phonological rule spreads [+nasal] from a nasal consonant onto a following vowel in forms such as madainn [mãt̪iNʲ] ‘morning’. However, just as stressed vowels may occasionally be lexically marked as [+nasal] in non-nasal environments, e.g. *amhaich* [ãfixʲ] ‘neck’, I will assume that the stressed vowel in a form such as *marag* [marak] ‘pudding’ is lexically [−nasal]. This results in the lexically-specific blocking of the spreading rule that is observed in forms of this type. An alternative analysis would be to simply assume that there is no spreading rule, and that vowel nasalisation is lexical in all cases. The choice between these two analyses is of no major consequence to the conclusions of this paper – what will be important is that forms such as *madainn* have a nasalised vowel in their phonological surface representation, while forms such as *marag* do not.

In a pilot version of this study, based on different data from a single speaker (S1 in this study; *see* Morrison 2018b), it was shown instrumentally that nasal airflow in items like *madainn* [mãt̪iNʲ] 'morning' is sustained at an elevated level throughout the duration of the vowel. Meanwhile, items like *marag* [marak] 'pudding' display a small amount of rapidly decreasing nasal airflow early in the vowel. The probable occurrence of a small amount of nasalisation even in forms of the latter type was acknowledged by Ternes (1973: 126) based on universal phonetic considerations. Following Cohn (1990; 1993) I interpret the plateau-like pattern of nasalisation in the former type as representing categorical phonological nasalisation, and the cline-like pattern in the latter as gradient phonetic nasalisation – which occurs without exception after a nasal consonant whenever phonological nasalisation fails to occur. Throughout this paper I mark categorical phonological nasalisation with a tilde in the transcription, while gradient phonetic nasalisation is left unmarked.

Under the *lenition* mutation in Scottish Gaelic, radical initial /p m/ both become [v].[3] Note that radical initial /v/ does not occur in native lexical roots; however, like other "lenited" consonants, non-alternating initial /v/ can occur outwith lenition contexts in function words (e.g. *bha* [va(ː)] 'be.PST'), loanwords (e.g. *bhòt* [voːʰt̪] 'vote'), placenames (e.g. *Bhaltos* [vɑL̥t̪ɔs] 'Valtos') and some irregular verb forms (e.g. *bheir* [vɛrʲ] 'give.NPST.INDEP'). When items such as *madainn* [mãt̪iNʲ] 'morning' – in which the following vowel displays categorical phonological nasalisation – are lenited, the vowel remains strongly nasalised, e.g. *mhadainn* [vãt̪iNʲ], and a variable amount of nasal airflow may also occur during [v] itself (Morrison 2018b; *cf.* Warner et al. 2015). The first part of this word is therefore quite different to the first part of *bhadan* [vat̪an] 'thicket', radical *badan* [pat̪an]. Since this nasalisation can be taken to be phonological, this is not an example of incomplete neutralisation. It is instead an example of paradigm uniformity at the level of categorical phonology: whether the mediating mechanism be cyclicity or OO-correspondence, the vowel of lenited *mhadainn* [vãt̪iNʲ] is phonologically nasalised as a result of its paradigmatic relationship with radical *madainn* [mãt̪iNʲ]. In accordance with the Stratal OT framework adopted throughout this thesis, I assume that the [+nasal] spreading rule mentioned above belongs to the stem level phonology, meaning that it applies to the radical stem before the occurrence of morphological operations such as initial mutation.

However, when items such as *marag* [marak] 'pudding' – in which the follow-

[3]A full treatment of lenition is provided in ch. 5, §5.2.2.

ing vowel displays only gradient phonetic nasalisation – are lenited, no nasalisation appears to remain, e.g. *mharag* [varak]. The first part of this word is therefore apparently identical to the first part of *bhara* [varə] 'barrow', radical *bara* [parə]. Any detectable difference between the first parts of these words would be an example of incomplete neutralisation. Under such a scenario, the fine-grained phonetic detail of *mharag* [varak] and *bhara* [varə] could be said to be influenced by their paradigmatic relationships with their respective radical forms. I now present an experiment that searches for such phonetic paradigm uniformity effects in order to determine whether incomplete neutralisation occurs in connection with initial mutation in Scottish Gaelic.

3.3 Nasal airflow study

In this section I report on a nasal airflow study that was carried out on four speakers of Scottish Gaelic from Ness, Lewis in order to determine whether lenition of radical initial /p m/ to [v] in Scottish Gaelic brings about incomplete neutralisation. The aims of the experiment are discussed in §3.3.1, the methods in §3.3.2 and the results in §3.3.3.

3.3.1 Aims

If categorical phonological nasalisation, but not gradient phonetic nasalisation, is sensitive to the paradigmatic relationship that exists between radical and lenited forms, it follows that the degree of nasalisation on the vowel following the initial [v] of a lenited form may be conditioned only by whether or not the vowel displays categorical phonological nasalisation in the corresponding radical form. It will not be conditioned by the presence or absence of gradient phonetic nasalisation in the radical form – i.e. by whether the initial consonant of the radical form is [p] or [m]. In other words, forms such as *bhara* [varə] 'barrow' and *mharag* [varak] 'pudding' – neither of which displays categorical phonological nasalisation in its radical form – will display, *ceteris paribus*, the same degree of nasalisation on the vowel as one another, even though the former alternates with a form in initial [p] and the latter with a form in initial [m]. Likewise, the degree of nasalisation on initial [v] itself – if any occurs at all – will also be conditioned only by the presence or absence of categorical nasalisation on the vowel of the corresponding radical form.

On the other hand, if gradient phonetic nasalisation is sensitive to paradigmatic relationships, the degree of nasalisation on the vowel of the lenited form will additionally be conditioned by the identity of the corresponding radical consonant. In other words, the vowel of *mharag* [varak] may display slightly greater nasal airflow than that of *bhara* [varə] as a result of the presence of gradient phonetic nasalisation in its radical form. Similarly, the degree of nasalisation on initial [v] itself may also be affected.

Under the former scenario, only the presence or absence of categorical phonological nasalisation in the radical form of a given lexical item will act as a significant predictor of the degree of nasalisation in its lenited form; under the latter scenario, however, the identity of the initial radical consonant will also play a significant role. The first aim of this experiment is therefore to test whether the degree of nasalisation on either the vowel of a lenited form, or on initial [v] itself, is sensitive only to the presence of categorical phonological nasalisation in the corresponding radical form, or whether it is additionally sensitive to the identity of the corresponding radical consonant.

Since many of the most widely studied examples of incomplete neutralisation relate to durational differences, it is also plausible that such effects might be found in the duration of initial [v]. Indeed, a cursory analysis of a separate data set (part of which is used in Morrison 2018b) shows that initial [p] in Scottish Gaelic is on average around 30% longer than initial [m] ($t(230.21) = -12.81$, $p < .001$). The second aim of this experiment is therefore to test whether the duration of the initial [v] of a lenited form is sensitive to the identity of the corresponding radical consonant.

3.3.2 Methods

Speakers

Four male speakers from Ness, Lewis, born between 1943 and 1952, took part in the experiment; these were speakers S1, S2, S3 and S5 from the experiment in ch. 2.[4] All were native speakers of Scottish Gaelic who were born and raised in Ness and

[4]These labels are employed here in order to facilitate identification with the same four speakers in ch. 2. For the avoidance of confusion, note that these same four speakers are referred to as S1, S4, S2 and S3 respectively in the published version of this paper (Morrison 2020).

lived there at the time of recording, although speakers S1 and S2 had both spent a significant proportion of their adult lives living on the Scottish mainland. All four were sufficiently literate in Scottish Gaelic to carry out the experimental task without difficulty.

Word list

16 lexical items – all either nouns or verbal nouns – were chosen for the target stimuli, of which eight began with radical /p/ and eight with radical /m/. The items in /m/ included four that were believed, based on auditory impression, to have categorical phonological nasalisation on the following vowel, and four that were believed to have only gradient phonetic nasalisation. Each item was presented both in its radical form, with initial [p m], and in its lenited form, with initial [v]. In the latter case, the item was embedded in either a prepositional phrase or a progressive verb phrase and lenition was triggered by either the preposition *a* [ə], the dative singular definite article *a’* [ə], the 2nd person singular possessive particle *do* [t̪ə], or the formally identical 2nd person singular object particle. The resulting 32 target items are shown in Table 3.1. Note that the items in /p/ and /m/ constitute eight near-minimal pairs closely matched for the quality of the following vowel and, for the most part, the consonant following that vowel.[5]

The target items were mixed with an equal number of filler items beginning with initial radical [p^h k^h k k^{jh} k^j f] and corresponding lenited [f x ɣ x^j j Ø]. The 32 target items and 32 fillers were presented to each speaker in a printed word list. Stimuli were presented in Scottish Gaelic orthography, alongside an English gloss to provide clarification in the event that a participant failed to recognise a word from its orthographic form. Each form occurred six times in the word list, making 384 items in total. Because the software being used allowed recording only in 10 s clips, these 384 items were split into 64 blocks of six and no carrier sentence was used. The items were randomised for each speaker, except for the following conditions:

- Alternate blocks each contained either only radical forms or only lenited forms. Because the stimuli containing lenited forms are considerably longer than those

[5]The item *b(h)uilgean* was erroneously spelt **b(h)uiligean* in the printed word lists.

Table 3.1: The 32 target items used in the experiment

Initial [p] ← radical /p/			**Initial [v] ← radical /p/**		
badan	[pat̪an]	‘thicket’	*às a’ bhadan*	[as ə vat̪an]	‘out of the thicket’
bara	[parə]	‘barrow’	*às a’ bhara*	[as ə varə]	‘out of the barrow’
Barabhas	[paravas]	‘Barvas’	*a Bharabhas*	[ə varavas]	‘to Barvas’
bàthadh	[paːhəɣ]	‘drown.VN’	*ga do bhàthadh*	[ɣa t̪ə vaːhəɣ]	‘drowning you’
beul	[piɑL]	‘mouth’	*na do bheul*	[na t̪ə viɑL]	‘in your mouth’
biast	[piəst̪]	‘beast’	*leis a’ bhiast*	[lʲɛʃ ə viəst̪]	‘with the beast’
Borgh	[pɔrɔɣ]	‘Borve’	*a Bhorgh*	[ə vɔrɔɣ]	‘to Borve’
builgean	[pʉlʲʉkʲan]	‘lump’	*anns a’ bhuilgean*	[as ə vʉlʲʉkʲan]	‘in the lump’

Initial [m] ← radical /m/			**Initial [v] ← radical /m/**		
madainn	[mãt̪iNʲ]	‘morning’	*anns a’ mhadainn*	[as ə vãt̪iNʲ]	‘in the morning’
marag	[marak]	‘pudding’	*leis a’ mharag*	[lʲɛʃ ə varak]	‘with the pudding’
marbhadh	[mara.əɣ]	‘kill.VN’	*ga do mharbhadh*	[ɣa t̪ə vara.əɣ]	‘killing you’
màthair	[mãːhərʲ]	‘mother’	*le do mhàthair*	[lʲe t̪ə vãːhərʲ]	‘with your mother’
meur	[mĩãr]	‘finger’	*le do mheur*	[lʲe t̪ə vĩãr]	‘with your finger’
mias	[mĩə̃s]	‘basin’	*às a’ mhias*	[as ə vĩə̃s]	‘out of the basin’
morghan	[mɔrɔɣan]	‘gravel’	*anns a’ mhorghan*	[as ə vɔrɔɣan]	‘in the gravel’
muilinn	[mʉlʲiNʲ]	‘mill’	*aig a’ mhuilinn*	[ɛkʲ ə vʉlʲiNʲ]	‘at the mill’

containing radical forms, this was felt necessary in order to allow the speaker to settle into a comfortable rhythm for each block.

- Within each block, the first, third and fifth items were target items while the second, fourth and sixth were fillers. This ensured that forms with the same initial consonant could not occur consecutively, while minimising the likelihood of a target item being lost off the end of a clip.

- The word list consisted of six equally-sized parts such that each form occurred exactly once in each. This ensured that the six repetitions of each form were spread relatively evenly throughout the list.

Recording

Recording was carried out using the PCquirer X16 multi-channel data acquisition system produced by Scicon R&D, Inc. The setup includes a nasal airflow mask which is attached by a flexible plastic tube to a transducer containing a built-in microphone. The transducer passes audio and nasal airflow data in two channels to the X16 system, which is in turn connected to a computer via a USB port. The system outputs an analogue in mV of air pressure or airflow rate.

Before the mask was placed on each speaker, a 10 s clip of zero airflow was recorded in order to determine the degree of DC-offset in the signal. Each speaker was then recorded reading aloud from the word list while wearing the nasal airflow mask. In accordance with the limitations of the software, each block of six items was recorded in one 10 s clip. However, to ensure that the speaker proceeded at a comfortable pace, they were not informed of the 10 s time limit for each block. It was expected that the speaker would usually finish all six items before the recording ended, although the loss of a small proportion of items was considered inevitable.

For radical forms of target items, all 384 potential tokens were successfully collected (96 from each speaker). For lenited forms of target items, 375 tokens were successfully collected (92 from S1, 94 from S2, 93 from S3 and 96 from S5). Eight tokens were lost due to the speaker failing to produce all three target items in the block within the 10 s time limit (four from S1, one from S2 and three from S3). One further lenited token from S2 was discounted due to the unexpected pronunciation of *bheul* 'mouth' with a monophthong [veːL] instead of a diphthong [viɑL]. A handful of other unexpected pronunciations were admitted into the data set as they were of no consequence to the study, such as the pronunciation of the progressive particle *ga* as [ka], in line with the standard orthography employed, rather than the usual Lewis form [ɣa].

Analysis

The recordings were segmented in Praat (Boersma 2001) using the audio track in order to determine the boundaries of the vowel following initial [p m] in radical forms, and the boundaries of both initial [v] and the following vowel in lenited forms (initial [p m] in radical forms were not segmented, since this would be impractical without a carrier sentence and comparison of these sounds is not of interest to the present study). A Praat script was then used to extract values for nasal airflow at one-16th intervals throughout each of these segments, including endpoints, resulting in 17 data points for each radical token and 33 for each lenited token. For each speaker, the DC-offset determined at the beginning of the session was subtracted from all values.[6] The system was calibrated using the CAL220 calibration device produced by Scicon R&D, Inc. in order to convert the output in mV of the nasal aiflow channel into values for nasal airflow rate expressed in ml / s. Linear mixed effects (LME) modelling was then carried out in R (R Core Team 2017), using the `lme4` package (Bates et al. 2015), in order to determine what factors condition the degree of nasalisation on the vowel following the initial [v] of lenited forms, the degree of nasalisation on [v] itself, and the duration of initial [v].

3.3.3 Results

Categorical and gradient patterns of nasalisation

Dynamic nasal airflow profiles for both radical and lenited forms, obtained by averaging across all tokens at each timepoint, were plotted in order to confirm the type of nasalisation displayed by each of the items used in this study. These are shown in Fig. 3.1, arranged in near-minimal pairs with items in /p/ on the left and those in /m/ on the right. Turning first to radical forms, all those in /p/ display no clear nasalisation, while all those in /m/ display some nasalisation. Nasal airflow in *madainn* [mãt̪iNʲ], *màthair* [mã:hərʲ], *meur* [mĩãr] and *mias* [mĩə̃s] falls rapidly after [m] but is sustained at an elevated level throughout the duration of the following vowel, although the exact level varies due to the greater oral impedance in high vowels than low vowels (*cf.* e.g. Cohn 1990; Huffman 1990; Li 2014). This effect is especially clear when comparing the low vowel of *màthair* [mã:hərʲ], in which nasal airflow is relatively low throughout, with the opening diphthongs of *meur* [mĩãr] and *mias* [mĩə̃s], in which nasal airflow is higher during the first part of the diphthong and then falls to a level

[6] In spite of this correction, the position of the baseline still appears to fluctuate somewhat for unknown reasons, meaning that the presumed absence of nasalisation may show up as a small positive or negative value. This has very little bearing on the analysis, since we are interested in the overall shape of the nasal airflow profile rather than absolute values of nasal airflow.

closer to that of *màthair* [mãːhərʲ] for the second part. Vowel length might also play a role, with the short low vowel of *madainn* [mãt̪iNʲ] displaying considerably higher nasal airflow than the long low vowel of *màthair* [mãːhərʲ]. Although the exact level of nasal airflow varies according to factors such as these, it is clear that the vowels of these four forms are nasalised throughout their entire duration. I take this as confirmation that these four lexical items display categorical phonological nasalisation. On the other hand, nasal airflow in *marag* [marak], *marbhadh* [mara.əɣ], *morghan* [mɔrɔɣan] and *muilinn* [mʉlʲiNʲ] falls rapidly after [m] and continues to fall to zero. I take this as confirmation that these four lexical items display only gradient phonetic nasalisation.

Turning now to lenited forms, items in radical /p/ generally show little to no nasalisation, although a certain amount of nasal airflow does sporadically occur during [v] in some items – especially before short low vowels. Those items in radical /m/ that display categorical phonological nasalisation in their radical forms, i.e. *mhadainn* [vãt̪iNʲ], *mhàthair* [vãːhərʲ], *mheur* [vĩãr] and *mhias* [vĩə̃s], display clear nasalisation on the vowel and, in the case of *mhadainn* [vãt̪iNʲ] – where [v] is followed by a short low vowel – a considerable amount of nasal airflow during [v] itself. On the other hand, those items in radical /m/ that display only gradient phonetic nasalisation in their radical forms, i.e. *mharag* [varak], *mharbhadh* [vara.əɣ], *mhorghan* [vɔrɔɣan] and *mhuilinn* [vʉlʲiNʲ], display similar profiles to items in radical /p/. This is consistent with the findings of Morrison (2018b).

Degree of nasalisation in lenited forms

The degree of nasalisation on (i) the vowel following the initial [v] of lenited forms and (ii) initial [v] itself is shown in Fig. 3.2. In those items with categorical nasalisation on the vowel of the corresponding radical form, a high degree of nasal airflow occurs during the vowel of the lenited form and some may also occur during [v]. In those items without categorical nasalisation in the corresponding radical form, nasal airflow is approximately zero in both the vowel and [v].

LME models were fitted to account for the degree of nasalisation on the vowel following the initial [v] of lenited forms. The dependent variable was the mean nasal airflow in ml / s across all 17 timepoints in the vowel (including endpoints) for each token. The null model contained fixed effects of categorical nasalisation (i.e. whether

Figure 3.1: Dynamic nasal airflow profiles of radical and lenited forms. 0 in normalised time marks the beginning of the initial consonant, 1 marks the end of the initial consonant and the beginning of the following vowel, and 2 marks the end of the vowel (note that only the vowel is shown for radical forms – airflow during [p] can be assumed to be approximately zero, and airflow during [m] to be higher than 100 ml / s).

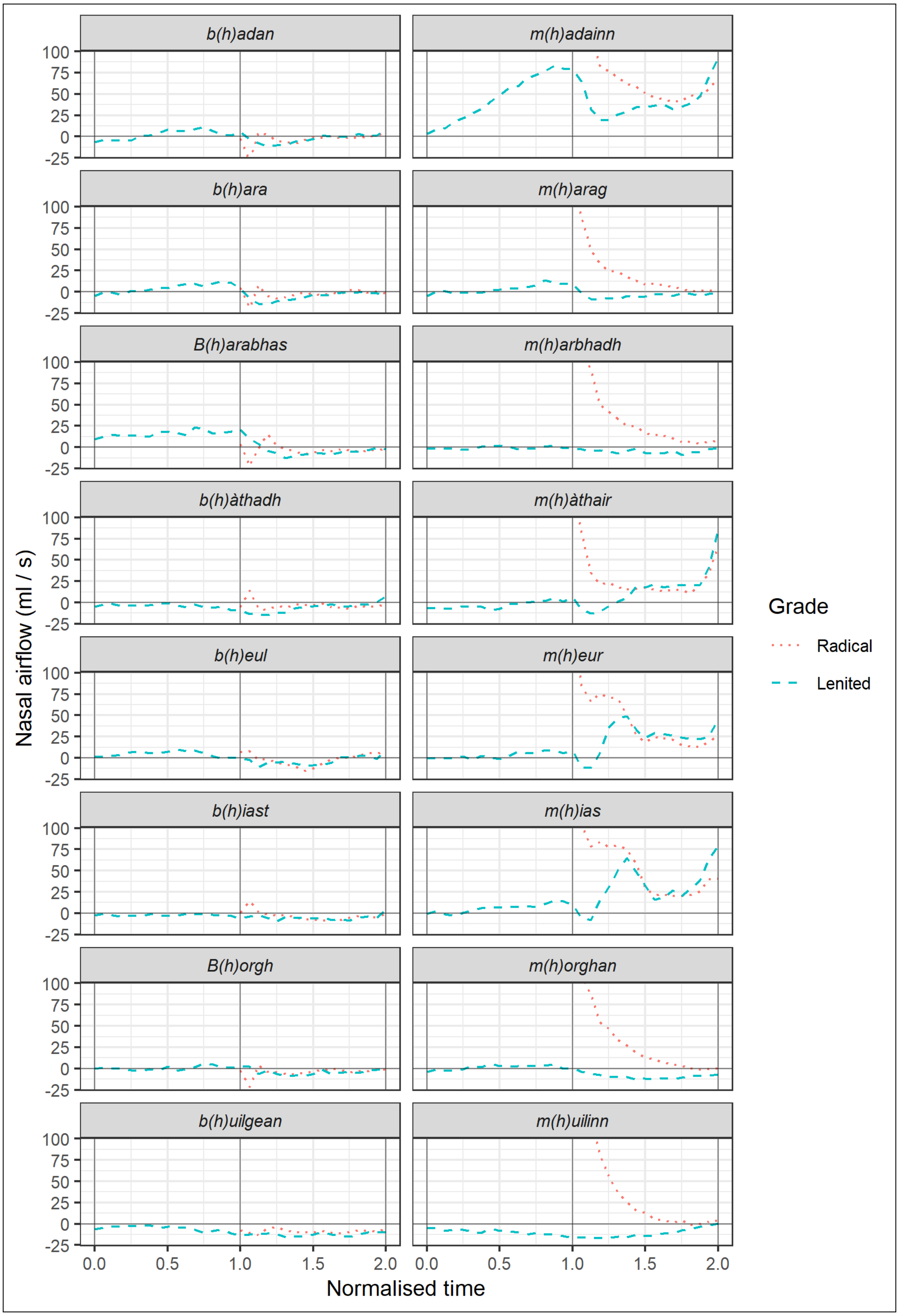
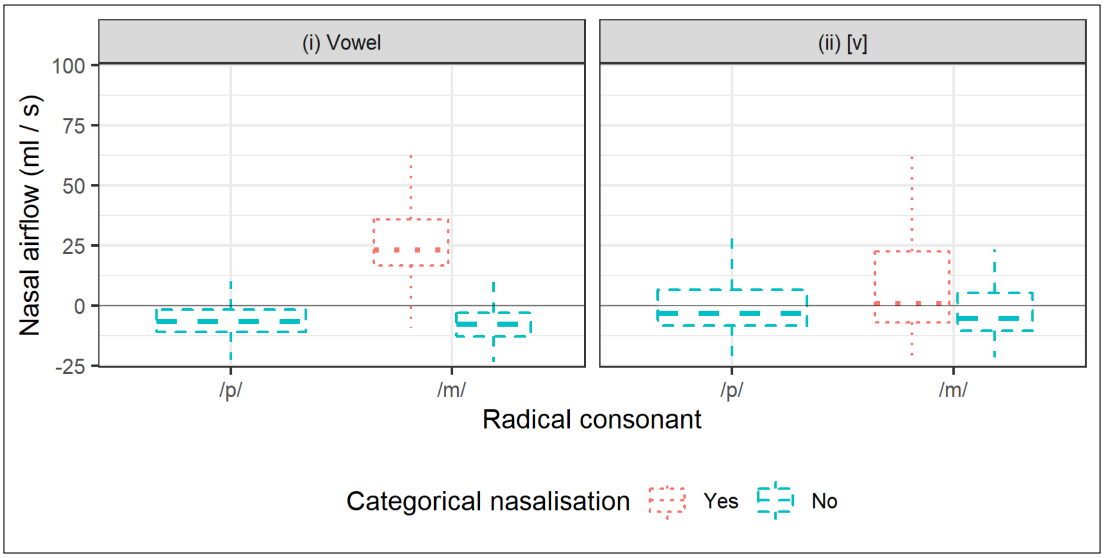


Figure 3.2: The degree of nasalisation on (i) the vowel following the initial [v] of lenited forms and (ii) initial [v] itself

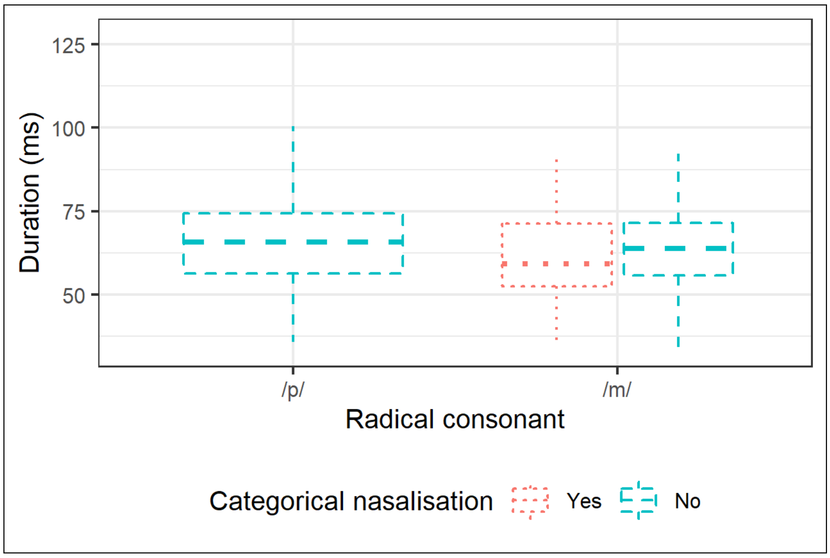


or not there is categorical phonological nasalisation in the corresponding radical form; two levels: yes, no) and vowel (six levels: /a/, /aː/, /ia/, /iə/, /ɔ/, /u/), and random intercepts in speaker and stimulus. The alternative model was identical except for the additional fixed effect of radical consonant (the identity of the corresponding radical consonant; two-levels: /p/, /m/). A likelihood ratio test (LRT) was carried out in order to determine whether the alternative model performed significantly better than the null model. No significant difference was found ($\chi^2(1) = 1.23$, $p = .267$). This suggests that the identity of the corresponding radical consonant has no significant effect on the degree of nasalisation on the vowel following the initial [v] of lenited forms.[7]

Similar LME models were fitted to account for the degree of nasalisation on initial [v] itself. This time, the dependent variable was the mean nasal airflow in ml / s across all 17 timepoints in [v] (including endpoints) for each token. All fixed and random effects were unchanged. Once again, an LRT was carried out in order to determine whether the alternative model performed significantly better than the null model. No significant difference was found ($\chi^2(1) = 2.21$, $p = .137$). This suggests that the identity of the corresponding radical consonant has no significant effect on the degree of nasalisation on the initial [v] of lenited forms.

[7]Because nasalisation in the radical forms of items such as *marag* [marak] is mostly confined to approximately the first half of the vowel, it could be suggested that averaging across the entire vowel might mask the presence of a significant effect early in the vowel. However, repeating the analysis using only those timepoints located in the first half of the vowel likewise reveals no significant effect ($\chi^2(1) = 0.77$, $p = .381$).

Figure 3.3: The duration of the initial [v] of lenited forms



Duration of initial [v] in lenited forms

The duration of the initial [v] of lenited forms is shown in Fig. 3.3. The duration appears to be similar across all conditions. Similar LME models were fitted, this time with the duration in ms of [v] for each token as the dependent variable. All fixed and random effects were again unchanged. Once again, an LRT was carried out in order to determine whether the alternative model performed significantly better than the null model. No significant difference was found ($\chi^2(1) = 0.058$, $p = .809$). This suggests that the identity of the corresponding radical consonant has no significant effect on the duration of the initial [v] of lenited forms.

3.4 Discussion

Incomplete neutralisation has been reported many times in Indo-European languages in connection with processes such as final devoicing, American English *t/d*-flapping and Russian unstressed vowel reduction, as well as in languages with very different morphological systems such as Chinese languages and Arabic. However, the few recent studies that have searched for incomplete neutralisation in initial mutation have found no convincing evidence for the phenomenon, and this study provides further evidence that it does not occur. Given that it is often observed in connection with other processes, the lack of any evidence for incomplete neutralisation in initial mutation raises the question of what makes initial mutation different. It might be suggested that mutational paradigms are structured in the mental lexicon in a fundamentally different manner to paradigms involving straightforwardly concatenative morphological processes. However, psycholinguistic experiments by Boyce et al. (1987) for Welsh and Ussishkin et al. (2017) for Scottish Gaelic have shown that the priming effects that different mutation grades of a single lexical item have on one another are similar to those observed between morphologically related forms in languages such as English. Schluter (2013) and Ussishkin et al. (2015) find similar results for Moroccan Arabic and Maltese respectively, which share a different kind of typologically unusual non-concatenative morphology based on consonantal templates.

One potential explanation is that radical forms occur less frequently than mutated forms and therefore do not act as a derivational base for mutated forms. However, mutated forms make up only 13.8% of tokens in the *CEG* corpus of written Welsh (Ellis et al. 2001). As for Scottish Gaelic specifically, the *DASG* corpus of Scottish Gaelic literature (`https://dasg.ac.uk/corpus/`) allows us to obtain a rough estimate of the relative token frequencies of radical and lenited forms. Among words beginning with those consonants for which lenition is marked orthographically, i.e. by insertion of a following *h* (*see* Appendix B), the initial consonant is followed by *h* in 33.3% of tokens in the corpus, suggesting that radical forms are almost exactly twice as frequent as lenited forms. Moreover, this figure is probably skewed in favour of lenited forms by the existence of a number of very high-frequency function words beginning with non-alternating, inherently "lenited" consonants such as *bha* [va(ː)] 'be.PST', *tha* [ha(ː)] 'be.PRS' and the negative particle *cha* [xa], so it is likely that radical forms outnumber lenited forms to an even greater degree among ordinary alternating lexical items. The lack of incomplete neutralisation in mutated forms is therefore probably not due to the relative token frequencies of radical and mutated forms.

A potential articulatory explanation for the lack of incomplete neutralisation in the lenition of /p m/ in Scottish Gaelic is that it would require nasalisation to occur on or adjacent to a fricative [v]. It is well-documented that fricatives (with an oral articulation forward of the velopharyngeal port) tend to be incompatible with nasalisation cross-linguistically, which Ohala (1975) and Ohala & Ohala (1993) ascribe to the articulatory challenge of producing sufficient oral airflow for frication to occur while simultaneously allowing air to escape through the nasal cavity. However, the presence of nasal airflow during [v] in *mhadainn*, shown in Fig. 3.1, suggests that this sound is quite amenable to nasalisation in Scottish Gaelic, and the results clearly show that it does not generally prevent nasalisation from occurring on a following vowel. In their nasal airflow study of putative nasalised fricatives in Scottish Gaelic, Warner et al. (2015) find that nasalisation, when it does occur during the articulation of the consonant, tends to co-incide with approximant-like realisations with no clear oral frication. It is therefore likely that [v] in Scottish Gaelic is not consistently articulated as a true fricative, and is thus not incompatible with nasalisation.

The majority of reported cases of incomplete neutralisation concern underlying contrasts that are faithfully represented in orthgraphy (e.g. German *Rat* vs. *Rad*), and there is evidence that the presence of incomplete neutralisation, or at least the degree of incompleteness that occurs, is dependent upon the salience of orthographic forms during elicitation (Fourakis & Iverson 1984; Jassem & Richter 1989; Warner et al. 2004; 2006; Kharlamov 2012; 2014). However, Kharlamov (2012: 194–195; 2014: 54) raises the possibility that orthography may play a role even when it is completely absent from the experimental set-up, citing evidence that orthographic representations form part of the grammatical knowledge of literate speakers (Tanenhaus et al. 1980; Treiman & Danis 1988; Ziegler & Ferrand 1998). If this is the case, then the strength of orthographic representations in a speaker's mental lexicon may affect the degree of incomplete neutralisation that occurs irrespective of the manner in which tokens are elicited. Since most speakers of minority languages like Scottish Gaelic (and other Celtic languages) receive relatively little exposure to the written language, it is highly probable that orthography would be far more weakly represented in the lexicons of speakers of those languages than for speakers of major national languages like Dutch, German, Polish and Russian. Although the spelling of [v] in Scottish Gaelic betrays its underlying radical form (e.g. *bhara* vs. *mharag*) just like neutralised final obstruents in German, such a difference in the strengths of orthographic representations in the mental lexicon could go part of the way to explaining why no convincing evidence has yet been found for incomplete neutralisation in initial mutation. Hall (2017: 14) raises a similar point with respect to the absence of orthographic effects in Levantine Arabic. However, it is unlikely that this alone could account for the different patterns observed.

Seyfarth et al. (2019) make the generalisation that incomplete neutralisation is restricted to cases where word-specific morphological pressures come into conflict with language-wide phonotactic constraints, based on their finding that it does not occur in connection with Javanese nasal substitution. In the case of final devoicing, the morphological requirement that a word such as German *Rad* /ʀaːd/ 'wheel' have a voiced final obstruent is pitched against a phonotactic requirement that word-final obstruents be voiceless, resulting in incomplete neutralisation with *Rat* /ʀaːt/ 'advice'. However, the neutralisation of the initial consonants of words such as Scottish Gaelic *marag* /marak/ 'pudding' and *bara* /parə/ 'wheelbarrow' in lenition contexts is driven not by phonotactic constraints but by the morphology itself. There is no general phonotactic ban on initial [v] in Scottish Gaelic, so no conflict occurs.[8] The results of this study are therefore consistent with Seyfarth et al.'s generalisation.

Relatedly, Hall (2017) suggests that incomplete neutralisation may be restricted to highly transparent, phonetically natural processes rather than more deeply morphologised ones. This conclusion is based on the differing properties of two phonological processes affecting vowels in Levantine Arabic, only one of which appears to bring about incomplete neutralisation. While Gouskova & Hall (2009) and Hall (2013) find subtle differences between underlying vowels and epenthetic vowels in Levantine Arabic, Hall (2017) finds no difference between underlyingly short vowels and underlyingly long vowels that have undergone a process of closed-syllable shortening. Hall ascribes this difference to the fact that vowel epenthesis in Levantine Arabic is a highly transparent process that serves to break up surface consonant clusters, while closed-syllable shortening occurs deeper in the phonology and interacts opaquely with morphological processes. While final devoicing in languages such as German can be regarded as highly transparent and phonetically natural, the alternations that occur as a result of initial mutation are directly tiggered by morphological processes and have no phonetic motivation. The negative results here and in other recent studies of initial mutation could thus be taken as further evidence in favour of Hall's claim.

If it is true that incomplete neutralisation is restricted to highly transparent, pho-

[8] Although radical initial /v/ does not occur in native lexical roots in Scottish Gaelic, recall from §3.2.3 that non-alternating initial /v/ may still freely occur in function words, loanwords, placenames and some irregular verb forms.

netically natural processes in which word-specific morphological pressures come into conflict with language-wide phonotactic constraints, this nevertheless does not appear to be a sufficient condition for its occurrence. Complete neutralisation has also been reported in connection with some processes that meet these criteria, such as manner neutralisation in coda consonants in Korean (Kim & Jongman 1996). Neutralisation of stem-final /t t^h s/ to [t] in coda position applies transparently and reflects the typologically common tendency for codas to permit fewer consonantal contrasts than onsets. Unless a vowel-initial suffix triggers resyllabification, the morphological requirement that a particular stem end in /t^h/ or /s/ comes into conflict with a phonotactic requirement that neither of these consonants occur in coda position. If Kim & Jongman's (1996) conclusion is correct, then it remains unclear why incomplete neutralisation should fail to occur in connection with this process.

Finally, a possible explanation for the lack of incomplete neutralisation in the lenition of /p m/ in Scottish Gaelic becomes apparent when the phonetic correspondences involved are considered at the gestural level. Most, possibly all, of the cases of incomplete neutralisation reported thus far can be regarded as paradigmatic effects on the timing and/or magnitude of corresponding articulatory gestures that are shared between morphologically related forms. For instance, the successive vocalic and closure gestures in German *Rad* [ʀaːt] 'wheel' have direct correspondents in the genitive form *Rades* [ʀaːdes]. However, the phonological plan for Scottish Gaelic *mharag* [varak] 'pudding' requires no velum-lowering gesture corresponding to that which produces nasalisation in the radical form *marag* [marak]. Rather, the occurrence of phonetic nasalisation in the former would require the addition of a velum-lowering gesture that would not otherwise be present in this form. Whatever the mechanism that lies behind phonetic paradigm uniformity effects, one possibility is that their occurrence is dependent upon the presence of corresponding articulatory gestures in morphologically related forms.

3.5 Conclusion

The existence of incomplete neutralisation continues to pose a challenge to strictly modular feedforward architectures of grammar. However, in order to determine exactly to what extent these theories must be modified in order to account for such phenomena, it is necessary to build a more complete picture of the precise circumstances that may bring about incomplete neutralisation. There remain many questions to be answered about the kinds of morphological alternations in which incomplete neutralisation may or may not occur, but this paper has reviewed the small number of existing studies of incomplete neutralisation in connection with one typologically unusual type of morphology and provided further evidence that the neutralisations it brings about are complete. These results help to bring us closer to an understanding of the structure of the mental lexicon and the processes that lie behind the derivation of morphologically complex forms.

Chapter 4

Metrical structure and the Class 1–Class 2 contrast: A Stratal OT analysis

4.1 Introduction

In several languages of northern Europe, words may display a suprasegmental contrast associated with the stressed syllable that manifests itself through differences in pitch, phonation, duration or a combination thereof.[1] For example, Swedish and Norwegian display two distinctive tonal accents, *Accent 1* and *Accent 2*, while the cognate opposition in Danish is realised by a form of glottalisation known as *stød* (Gårding 1973). Similarly, some Franconian dialects contrast two tonal accents accompanied by differences in duration (Gussenhoven & Peters 2004; Peters 2006). Meanwhile, heavy stressed syllables in Estonian distinguish both normal length and overlength, each with its own characteristic pitch contour (Lehiste 1960). As noted by Ternes (1980, 2006: ch. 5), a microcosm of these phenomena is found in Scottish Gaelic, where forms belonging to two phonological classes – termed *Class 1* (henceforth C1) and *Class 2* (henceforth C2) in this paper – are distinguished in different dialects by means of either tonal accent, glottalisation or overlength. Tonal accent is used in Lewis (Borgstrøm 1940; Oftedal 1956), glottalisation in Islay (Holmer 1938), and overlength

[1]This chapter is based on a post-peer-review, pre-copyedit version of an article published in *Phonology* as Morrison (2019) (doi: `https://doi.org/10.1017/S0952675719000204`).

in Applecross, Ross-shire (Borgstrøm 1941; Ternes 1973):

(1)

		Lewis	Islay	Applecross	
a.	C1				
	dubhan	[t̪úan]	[t̪uˀan]	[t̪uan]	'hook'
	bodha	[pô:]	[poˀu]	[po:]	'submerged rock'
	aran	[áran]	[aˀran]	[aran]	'bread'
b.	C2				
	uan	[uán]	[uan]	[ua·n]	'lamb'
	bò	[pǒ:]	[pou]	[po:·]	'cow'
	arm	[arám]	[arəm]	[ara·m]	'army'

In Lewis, C1 forms display a pitch peak on the first mora and C2 forms on the second. Meanwhile, in Islay, C1 forms are distinguished from C2 forms by a period of glottalisation between the first two morae. Finally, in Applecross, C1 forms show normal length while C2 forms exhibit overlength through elongation of the second mora.

It has long been argued that the contrast between long and overlong syllables in Estonian reflects a difference in the extent of the foot (Prince 1980; Odden 1997), and a number of recent analyses have likewise invoked metrical structure in order to derive the tonal accent contrasts in Swedish (Morén-Duolljá 2013) and Franconian (Köhnlein 2011; 2016; 2018a;b; Hermans 2012; Kehrein 2018; van Oostendorp 2018), as well as Danish stød (Iosad 2016). The contrast between C1 and C2 forms in Scottish Gaelic has also been ascribed to metrical structure in various ways, sometimes involving complex multi-layered structures such as "super-syllables" (Bosch & de Jong 1998) or recursive syllables (Smith 1999). In accordance with numerous other authors (Oftedal 1956; Hind 1996; 1997; Ladefoged et al. 1998; Hall 2003; 2006; Ladefoged 2003; Wentworth 2005; Iosad 2015), I argue that the contrast directly reflects the extent of the stressed syllable: specifically, in C1 forms, the stressed syllable contains only the first mora while in C2 forms it contains the first two. Unlike most of the aforementioned analyses of other languages, however, I will argue that the metrical structure – and hence the phonological class membership – of a form in Scottish Gaelic is predictable from its underlying segmental content: in other words, the metrical contrast between C1 and C2 forms is a derived one. Scottish Gaelic can therefore be thought of as representing an intermediate step on the diachronic trajectory that historically led to the lexically contrastive metrical structure proposed for those languages in the present day.

The analysis presented in this paper uses the framework of Stratal OT outlined in ch. 1, §1.1. I argue that metrical structure in Scottish Gaelic is built in the stem-level phonology in a regular manner, but may subsequently be rendered opaque by segmental operations at the word level – in particular, a process of copy epenthesis known as *svarabhakti*, which creates syllables containing two vocalic sonority peaks. In this way, the present analysis is similar to van Oostendorp's (2018) analysis of tonal accent on pre-obstruent short vowels in Moresnet Franconian. Drawing on the proposals of Köhnlein (2016; 2018a) for Franconian tonal accent, I claim that faithfulness to foot structure preserves the stem-level syllable count when svarabhakti occurs, resulting in a word-level contrast between disyllabic and monosyllabic feet – even in sequences with identical segmental content. These differing metrical structures are then reflected on the surface by means of either tonal accent, glottalisation or overlength depending on dialect.

This paper demonstrates the ability of Stratal OT to account for the highly complex intricacies of Scottish Gaelic phonology in a principled manner, and aims to provide the most complete and thorough analysis to date of the C1–C2 contrast in Scottish Gaelic. Additionally, by demonstrating how the same surface metrical contrast may be realised in different dialects of a single language by means of either tonal accent, glottalisation or overlength, this paper hopes to bring closer together the various existing metrical analyses of these phenomena in languages such as Swedish, Danish, Franconian and Estonian.

A considerable amount of dialectal variation exists in Scottish Gaelic and it is necessary to limit any detailed analysis to a single variety. This paper will focus primarily upon the dialect of Lewis in the Outer Hebrides, where the C1–C2 contrast is realised through tonal accent. When not stated otherwise, all forms cited in this paper are from this dialect. Within Lewis, Borgstrøm (1940) provides a detailed description of the dialect of Bernera in the west of the island, as well as some additional notes on that of Ness in the far north, while Oftedal (1956) describes in detail the dialect of Leurbost in the east of the island. As far as possible, the Lewis forms cited in this paper are limited to those found either in those two sources or in Ladefoged et al. (1998), which revisits the dialect of Bernera; however, they are occasionally supplemented by forms from *SGDS* or from my own fieldwork in Ness. When a generalisation is made over all of the Lewis data, this should be taken to encompass all Lewis forms cited in Borgstrøm (1940), Oftedal (1956) and Ladefoged et al. (1998) to the exclusion of compound forms, on which too little data is available for any systematic treatment, and transparent English or Scots loans, which do not always display full assimilation into the phonological system of Scottish Gaelic.

4.1.1 Slenderisation

Before we proceed with the analysis, it is necessary to introduce an important aspect the morphophonology of Scottish Gaelic. Numerous morphological categories, such as genitive case or plural number in many nouns and comparative degree in adjectives, are marked by means of a morphophonological process known as *slenderisation*, which targets the stem-final rhyme and converts broad consonants into their slender counterparts. If the stem is monosyllabic, slenderisation is often accompanied by an alternation in the vowel which I will refer to as *ablaut*.[2] Importantly, both broad fortis [N] and broad lenis [n] alternate with slender fortis [Nʲ] under slenderisation:[3]

(2) a. [N] alternates with [Nʲ]

ceann	[kʲʰaúN]	'head'	GEN *cinn*	[kʲʰeíNʲ]
cracann	[kʰráʰkəN]	'skin'	GEN *cracainn*	[kʰráʰkiNʲ]

b. [n] alternates with [Nʲ]

amhran	[aúran]	'song'	GEN *amhrain*	[aúraNʲ]
uan	[uán]	'lamb'	GEN *uain*	[uáNʲ]

Additionally, broad fortis [L] may alternate with either slender fortis [Lʲ] or slender lenis [lʲ] under slenderisation:

(3) a. [L] alternates with [Lʲ]

Dòmhnall	[t̪ǒːəL]	'Donald'	GEN *Dhòmhnaill*	[ɣǒːiLʲ]
peirceall	[pʰéɾ̥ʲkʲəL]	'jaw'	PL *peircill*	[pʰéɾ̥ʲkʲiLʲ]

[2] A full treatment of slenderisation is provided in ch. 5, §5.2.1.

[3] In Bernera and Ness, broad lenis [n] remains unchanged if it is preceded by a stressed slender vowel in the slenderised form, e.g. *grian* [krʲiə́n] 'sun', genitive *grèine* [krʲěːnə] (*cf. ciall* [kʲʰiə́L] 'sense', genitive *cèille* [kʲʰěːLʲə], of the same declensional class and with the same ablaut alternation). In Leurbost it always becomes [Nʲ].

b. [L] alternates with [lʲ]

diabhal	[tʲiə́vəL]	‘devil’	GEN *diabhail*	[tʲiə́vəlʲ]
saoghal	[sɯ̆ɯː vəL]	‘world’	GEN *saoghail*	[sɯ̆ɯː vəlʲ]

I take these alternations to indicate the existence of word-level *fortition* processes that convert certain underlyingly lenis coronal sonorants into fortis ones, resulting in the absence of slender lenis *[nʲ] and broad lenis *[l] on the surface. I will assume that fortis [Nʲ] and [L] represent underlyingly lenis sonorants whenever they are seen to alternate with lenis [n] and [lʲ] respectively. Throughout the present paper, slenderisation alternations will occasionally be used in examples to show that a particular instance of [Nʲ] or [L] is underlyingly lenis.

The structure of the paper is as follows. §4.2 shows that the C1–C2 contrast directly reflects the extent of the stressed syllable, and establishes the surface metrical structure of various types of C1 and C2 forms. It is shown that, in most cases, this follows from surface segmental content. §4.3 argues that the remaining cases – containing monosyllabic sequences with two vocalic sonority peaks – result from a regular phonological process of copy epenthesis known as *svarabhakti*. §4.4 argues that svarabhakti is a word-level process that depends on a mora projected by a coda sonorant at the stem level, and establishes the stem-level outputs upon which svarabhakti acts, while §4.5 offers an Optimality Theoretic account of svarabhakti, showing how faithfulness to input foot structure can bring about the observed monosyllabic sequences. §4.6 discusses how the differing metrical structures of C1 and C2 forms are realised on the surface in different dialects of Scottish Gaelic. §4.7 provides some general discussion and §4.8 concludes the paper.

4.2 Surface metrical structure

Recall from §1.2.3 that almost all non-compound content words in Scottish Gaelic bear initial stress. No secondary stress occurs except in synchronic compound forms, which will not be considered here since too little data is available for any systematic treatment of words of this type. In most cases, whether a form belongs to C1 or C2 simply depends on the length of the stressed vowel: if the stressed vowel is short then the form belongs to C1, realised in Lewis with a pitch peak on the first mora of the word, and if the stressed vowel is long then it belongs to C2, with a peak on the second mora. More generally, the pitch peak can thus be said to occur on the rightmost mora of the stressed vowel. However, under certain circumstances, the phonological class of a form may not follow straightforwardly from its overt surface segmental content. This can result in minimal pairs:

(4)	C1			C2		
	dubhan	[t̪úan]	'hook'	*duan*	[t̪uán]	'poem'
	bodha	[pôː]	'submerged rock'	*bò*	[pǒː]	'cow'
	ballag	[páLak]	'skull'	*balg*	[paLák]	'bag'

In this section I show that the C1–C2 contrast directly reflects the extent of the stressed syllable in forms such as those in (4). I provide independent evidence that in C1 forms – which bear the first-mora pitch peak typical of a short stressed vowel – the stressed syllable contains only the first mora of the word, while in C2 forms – which bear the second-mora peak typical of a long stressed vowel – it contains the first two. This in turn leads to a difference in foot structure: in C1 forms the foot consists of two monomoraic syllables, while in C2 forms it consists of one dimoraic syllable. This section will build upwards through the prosodic hierarchy from the mora in §4.2.1, through the syllable in §4.2.2, to the foot in §4.2.3, in order to establish the surface metrical structure of the various types of C1 and C2 forms illustrated in (4).

4.2.1 The mora

I assume that onset consonants are attached directly to the syllable node while coda consonants may either head a mora of their own, in which case they contribute to syllable weight, or else attach to the nearest mora to their left, in which case they are weightless (Hayes 1989; Broselow et al. 1997). Geminate consonants are overtly moraic; otherwise, moraic consonants may be diagnosed in codas whenever VC rhymes are seen to pattern with VV rhymes in some way, e.g. by attracting stress (as in Latin) or satisfying a word-minimality condition (as in English). Smith (1999: 618) and Hall (2003: 109) claim that evidence of the latter type exists in Lewis Gaelic, citing a process of final *h*-epenthesis that affects short open monosyllables, e.g. *crodh* [k^{h}ró^{h}] 'cattle', *dubh* [t̪ú^{h}] 'black'. According to their analysis, *h*-epenthesis serves to satisfy a word-minimality condition by providing a monomoraic word with a coda. It follows from this that coda consonants must generally be moraic in Lewis Gaelic – at least when preceded by a short stressed vowel. However, *h*-epenthesis normally only occurs before pausa (Borgstrøm 1940: 74, Oftedal 1956: 116), which is unexpected if it serves to satisfy a general word-minimality condition. Additionally – and in agreement with Ternes (1973: 84) for Applecross, Ross-shire and Wentworth (2005: 446) for Gairloch, Ross-shire — my own observations suggest that *h*-epenthesis forms just part of a more general devoicing process that also affects all voiced coda consonants in exactly the same environment, e.g. *bean* [pɛ́n̥] 'wife', *geal* [kʲáL̥] 'white', and thus cannot be motivated by the need for a coda consonant. In accordance with Green (1997) for modern Goidelic in general, I therefore believe there is no evidence that coda consonants are moraic on the surface in Lewis Gaelic – although I claim in §4.4 that moraic coda consonants *do* occur at an intermediate stage of the phonological derivation before subsequently transferring their morae to adjacent vowels. It will also be seen that overtly moraic (i.e. geminate) coda consonants may occur on the surface in other dialects which lack these mora-transfer processes.

4.2.2 The syllable

There are three sets of circumstances under which the phonological class of a form in Lewis Gaelic may not follow straightforwardly from its overt surface segmental content. In each case, there is independent evidence that the stressed syllable contains only the first mora in C1 forms and the first two morae in C2 forms. First of all, certain ˈV_iV_j sequences (where V_i and V_j are two short vowels) may occur with either the first-mora pitch peak of C1 or the second-mora peak of C2:

(5)	C1 ˈV_iV_j			C2 ˈV_iV_j		
	aghaidh	[ɣ́i]	'face'	*aoidh*	[ɣí]	'isthmus'
	dubhan	[t̪úan]	'hook'	*duan*	[t̪uán]	'poem'
	fitheach	[fíəx]	'raven'	*fiach*	[fiə́x]	'value'
	meadhan	[mían]	'middle'	*eun*	[ián]	'bird'
	ubhal	[úəL]	'apple'	*gual*	[kuə́L]	'coal'

There is evidence that C1 ˈV_iV_j sequences are hiatus sequences and C2 ˈV_iV_j sequences are diphthongs. Phonotactically, a C1 ˈV_iV_j sequence may generally contain any vowel that is allowed in a stressed syllable followed by any vowel that is allowed in an unstressed syllable; on the other hand, C2 ˈV_iV_j sequences are restricted to certain pairs of vowels, *viz.* [iə́ iá uə́ uá] and various combinations ending in [í] or [ú]. Additionally, C2 ˈV_iV_j sequences behave as if monosyllabic under slenderisation. Recall from §4.1.1 that slenderisation may be accompanied by vowel ablaut in monosyllabic stems. Under slenderisation, C2 ˈV_iV_j sequences frequently undergo ablaut alternations with long vowels:

(6) *feur* [fiár] 'grass' GEN *feòir* [fɛ̯ɔ̌ːrʲ]
iasg [iə́sk] 'fish' GEN *èisg* [ěːʃkʲ]

Accordingly, I consider a C1 ˈV_iV_j sequence to consist of two vowels in hiatus, so that only the first mora belongs to the stressed syllable; meanwhile, I will consider a C2 ˈV_iV_j sequence to represent a diphthong, so that the stressed syllable contains the first two morae. We can therefore uphold the generalisation that the stressed syllable is monomoraic in C1 forms, e.g. *dubhan* [t̪ú$_\mu$]$_\sigma$ [a$_\mu$n]$_\sigma$ 'hook', and dimoraic in C2 forms, e.g. *duan* [t̪u$_\mu$á$_\mu$n]$_\sigma$ 'poem'.

Secondly, a word-final long vowel may occur with the first-mora pitch peak of C1 rather than the second-mora peak of C2:

(7) C1 long vowels

bodha	[pôː]	'submerged rock'	*lugha*	[Lɯ̂ː]	'small.CMP'
fighe	[fîː]	'knit'	*ogha*	[ɔ̂ː]	'grandchild'
latha	[Lâː]	'day'	*rubha*	[Rûː]	'promontory'
leatha	[lʲɛ̂ː]	'with.3SG.F'	*teatha*	[t̪ʰêː]	'tea'

There is evidence that C1 long vowels are actually hiatus sequences. Forms of this type generally exist in free variation with forms containing a straightforward hiatus sequence of a short vowel + [ə], e.g. [póə], [fíə],[4] and only the latter allomorph occurs under suffixation ([i] is the regular outcome of /ə/ before [xʲ]):

[4]In the body of the text, Borgstrøm (1940) only ever transcribes forms with [ə] for words of this type (*b̯oˋə*, *fiˋə* in his transcription), which suggests that C1 long vowels don't occur in Bernera (except in sporadic cases as mentioned in footnote 5 below). However, the word *gobha* 'smith', transcribed *g̯oˋə* (= [kóə]) on p. 31, is consistently transcribed *g̯oˋo* (= [kôː]) in a sample text about a blacksmith (pp. 246–247).

(8) *latha* [Lâː] ‘day’ PL *lathaichean* [Lái-xʲən]
ogha [ɔ̂ː] ‘grandchild’ PL *oghaichean* [ɔ́i-xʲən]

Accordingly, I consider a C1 long vowel to simply be a special case of hiatus in which an optional word-level phonological process has caused underlying word-final /ə/ to assimilate in quality an immediately preceding short stressed vowel. Again, we can therefore uphold the generalisation that the stressed syllable is monomoraic in C1 forms, e.g. *bodha* [pó$_\mu$]$_\sigma$ [o$_\mu$]$_\sigma$ ‘submerged rock’.[5]

For the phonological representation of hiatus sequences I take an approach expanding on that of Clements (1986) and assume that all apparently empty onsets in Scottish Gaelic actually contain an underspecified consonant [$X^{(j)}$], e.g. *dubhan* [t̪úXan] ‘hook’, *bodha* [póXo] ‘submerged rock’. As discussed in ch. 5, §5.4.5, there is independent evidence for an underspecified consonant of this sort in both Scottish Gaelic and Irish. The differing syllabification of hiatus sequences on the one hand, and long vowels and diphthongs on the other, therefore follows from their surface segmental content – as with an ordinary VCV sequence, two vowels separated by [$X^{(j)}$] project two separate syllables, while a long vowel or diphthong projects a single syllable.

Finally, a ˈ$V_i CV_i$ sequence (where V_i is a short vowel) containing a sonorant may occur with the second-mora pitch peak of C2 rather than the first-mora peak of C1:

(9) C2 ˈ$V_i CV_i$

balg	[paLák]	‘bag’	*failm*	[fɤlʲɤ́m]	‘helm’
crannchar	[kʰraNáxər]	‘fate’	*fairrge*	[faRákʲə]	‘rough sea’
currcag	[kʰuRúʰkak]	‘lapwing’	*imleag*	[imílʲak]	‘navel’
dorgh	[t̪ɔrɔ́ɣ]	‘fishing line’	*seanmhair*	[ʃɛnɛ́varʲ]	‘grandmother’

C2 ˈ$V_i CV_i$ sequences are referred to as *svarabhakti groups* and the second vowel is often referred to as a *svarabhakti vowel*. There is evidence that svarabhakti groups are in fact monosyllabic. Phonotactically, svarabhakti vowels display the full range of qualitative contrasts found in stressed syllables and are not subject to the same restrictions as unstressed vowels. Additionally, as noted by Hall (2003: 101–102, 2006: 400) and Iosad

[5] C1 long vowels, as long as they are of a quality that can occur in unstressed syllables, may also sporadically occur non-finally where they can be regarded as the result of chance juxtaposition of two identical vowels in hiatus, e.g. *drathair* [t̪râːrʲ] ‘drawer’ (containing the common suffix [-arʲ] normally used to render English *-er* in loans), *fithich* [fîːxʲ] ‘raven.GEN’ (slenderised form of *fitheach* [fíəx], with /ə/ > [i] before [xʲ]).

(2015: 31), svarabhakti groups behave as if monosyllabic under slenderisation. Recall from §4.1.1 that slenderisation normally targets consonants in stem-final rhymes, and that it may be accompanied by ablaut in monosyllabic stems. If the consonant immediately following a svarabhakti group undergoes slenderisation, so does the intervening sonorant; meanwhile, ablaut affects both vowels:

(10) *balg* [paLák] 'bag' GEN *builg* [pulʲúkʲ]
dorgh [t̪ɔrɔ́ɣ] 'fishing line' GEN *duirgh* [t̪urʲúj]

Accordingly, I consider svarabhakti groups to be monosyllabic. Once again, we can therefore uphold the generalisation that the stressed syllable is dimoraic in C2 forms, e.g. *balg* [pa$_\mu$Lá$_\mu$k]$_\sigma$ 'bag'.

These syllable counts are supported by speaker intuitions at least to some extent (Borgstrøm 1937: 78, 1940: 153, Oftedal 1956: 29, Wentworth 2005: 19, Hammond et al. 2014), and are consistently reflected in poetic metre (Oftedal 1956: 29, O'Rahilly 1972: 201, Wentworth 2005: 19–20). Many other authors have reached similar conclusions, particularly with regard to svarabhakti groups (Oftedal 1956; Hind 1996; 1997; Ladefoged et al. 1998; Hall 2003; 2006; Ladefoged 2003; Wentworth 2005; Iosad 2015). Although a syllable containing a svarabhakti group therefore has a highly marked sonority profile containing two vocalic sonority peaks, Oftedal (1956: 29) points out that this is consistent with the fact that only the most sonorous consonants are allowed to intervene between the two vowels.

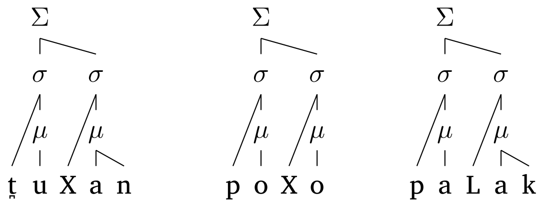
4.2.3 The foot

Since words in Scottish Gaelic almost always have initial stress, I assume that every non-compound content word with non-exceptional stress contains a trochaic foot aligned with its left edge. The least marked type of trochaic foot is generally considered to be one that contains either two monomoraic syllables or one dimoraic syllable (Hayes 1995; Hyde 2011), so I will assume by default that all feet (in words of two or more morae) are of this type in Scottish Gaelic. Coupled with the facts of moraic and syllabic structure established in the previous sections, this leads to the following phonological surface representations for the minimal pairs in (4):[6]

[6] I assume that the intervening sonorant in a svarabhakti group attaches to the mora headed by the preceding vowel, in order to maintain the generalisation that a non-moraic consonant in the rhyme

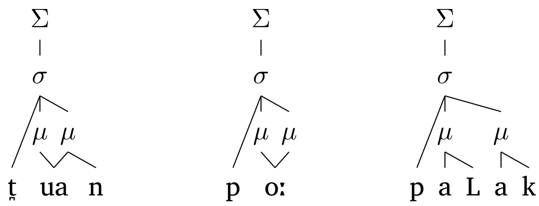
(11) a. C1

dubhan [t̪úan] *bodha* [pôː] *ballag* [páLak]



b. C2

duan [t̪uán] *bò* [pǒː] *balg* [paLák]



Note that this now allows us to view the C1–C2 contrast as reflecting a difference in foot structure: in C1 words the foot consists of two monomoraic syllables, while in C2 words it consists of one dimoraic syllable.

4.3 The synchronic status of svarabhakti

Although I argued in §4.2.2 that the differing syllabification of hiatus sequences on the one hand, and long vowels and diphthongs on the other, follows from their surface segmental content, the unusual syllabification of svarabhakti groups is yet to be explained. This part of the analysis argues that svarabhakti vowels are the result of a regular phonological process known as *svarabhakti*, which breaks up heterorganic consonant clusters whose first member is a sonorant. §4.3.1 discusses the regular distribution of svarabhakti vowels in Lewis Gaelic and §4.3.2 deals with some apparent irregularities. §4.3.3 discusses the manner in which svarabhakti interacts with a phenomenon of stem-internal /ə/-syncope in suffixed forms, and shows that the latter represents suppletive stem allomorphy.

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attaches to the nearest mora to its left. However, this choice has no bearing on the analysis.

4.3.1 The distribution of svarabhakti vowels

Virtually all phonological work on svarabhakti has either argued or assumed that svarabhakti vowels are not present underlyingly but rather are derived via either epenthesis (Ó Dochartaigh 1981; Clements 1986; Bosch 1994; Ní Chiosáin 1994; Halle 1995; Green 1997; Smith 1999; Halle et al. 2000; Iosad 2015; Stanton & Zukoff 2018) or gestural realignment (Hind 1996; 1997; Hall 2003; 2006). The quality of the svarabhakti vowel is predictable from its environment: in Lewis it is of the same quality as the preceding vowel (Borgstrøm 1940; Oftedal 1956), in Barra it is of the same height as the preceding vowel but assimilates in slenderness to the intervening sonorant (Borgstrøm 1937; 1940), and in Argyll it is realised as [ə] (Holmer 1938). Normally, the svarabhakti vowel must be followed by a consonant that is heterorganic with the intervening sonorant, and for any heterorganic pair of a sonorant + another consonant there is a complementary relationship between the circumstances under which they may surround a svarabhakti vowel and those under which they may form a cluster. The rule and some corresponding examples follow, with the relevant consonants and any intervening svarabhakti vowel underlined in each case (recall from ch. 1, §1.2.1 that preaspiration is realised as devoicing of any preceding sonorant):[7]

(12) If

a. the sonorant is preceded by a short vowel, and

i. the sonorant is fortis → svarabhakti

crannchar	[kʰraNáxər]	'fate'
currcag	[kʰuRúʰkak]	'lapwing'
fairrge	[faRákʲə]	'rough sea'
imleag	[imílʲak]	'navel'

ii. the sonorant is lenis, and

A. the other consonant is a pre-aspirated stop → cluster

cearc	[kʲʰɛ́r̥k]	'hen'
corp	[kʰɔ́r̥p]	'body'
olc	[ɔ́L̥k]	'evil' (*cf.* GEN *uilc* [úl̥ʲkʲ])
peirceall	[pʰér̥ʲkʲəL]	'jaw'

[7]Note that the syllabic affiliation of the consonants is irrelevant: the rule is the same regardless of whether or not they belong to the same syllable.

B. the other consonant is not a pre-aspirated stop → svarabhakti

balg	[paLák]	‘bag’ (*cf.* GEN *builg* [pulʲúkʲ])
dorgh	[t̪ɔrɔ́ɣ]	‘fishing line’
failm	[fɤlʲɤ́m]	‘helm’
seanmhair	[ʃɛnɛ́varʲ]	‘grandmother’

b. the sonorant is preceded by a long vowel or diphthong → cluster

àrc	[ăːr̥k]	‘cork’
eumraich	[ĕːmrixʲ]	‘lowing’
Liùrbost	[Lʲŭːrpɔst̪]	‘Leurbost’
mìorbhail	[miə́rvalʲ]	‘miracle’

Unfortunately, the morphology of Scottish Gaelic provides almost no opportunity to demonstrate the productivity of svarabhakti through alternations. Although there is a phenomenon of stem-internal /ə/-syncope that feeds svarabhakti by bringing together clusters of the appropriate type, I show in §4.3.3 that syncopated stems are synchronically suppletive. Consonant-initial suffixes are rare in Scottish Gaelic, and those that do occur with any degree of productivity all begin with a coronal – meaning that the only logically possible way for suffixation to feed svarabhakti is if one of these suffixes happens to combine with a stem ending in /m/. Such a combination does not occur in the Lewis data, but Wentworth (2005) records the form *cuimte* [kʰumúʰtʲə] ‘well-shaped’ for Gairloch in Ross-shire – from the verb *cùm* ‘shape’ (which he does not record, but presumably [kʰŭːm] with lengthening of underlyingly short /u/, *see* §4.4.1) + the adjectival suffix *-te* [-ʰtʲə] – in which svarabhakti occurs as predicted. Svarabhakti can also be observed in English loans such as *bargan* [parákan] ‘bargain’ or *targaid* [t̪ʰarákatʲ] ‘target’, but the exact age of these loans is not clear. The claim that svarabhakti is a synchronic process is therefore based primarily on the predictable quality and regular distribution of svarabhakti vowels. I assume that all forms with svarabhakti contain an underlying heterorganic cluster of a sonorant + another consonant, e.g. *fairrge* /faRkʲə/ ‘rough sea’, *dorgh* /t̪ɔrɣ/ ‘fishing line’, and that svarabhakti occurs in order to break up clusters of this type unless either (i) the sonorant is lenis and the other consonant is a pre-aspirated stop, or (ii) the sonorant is preceeded by a long vowel or diphthong. I will follow several authors in assuming that the svarabhakti vowel acquires its quality through autosegmental feature spreading (Clements 1986;

Ní Chiosáin 1994; Halle 1995; Halle et al. 2000), but this aspect of the phenomenon lies outwith the scope of the present paper.

4.3.2 Apparent irregularities

Lewis Gaelic displays a number of apparent exceptions to the rule in (12), most of which fall into two groups. First of all, a set of forms exists in which svarabhakti appears to overapply before hiatus:

(13)	*Aonghas*	[ɯnɯ́əs]	*[ɯ́nəs]	‘Angus’
	falbhaidh	[faLái]	*[fáLi]	‘leave.NPST’
	mailghean	[maLáən]	*[máLən]	‘eyebrow.PL’
	marbhaidh	[marái]	*[mári]	‘kill.NPST’

Recall from §4.2.2, however, that for independent reasons I consider hiatus (and all other apparently empty onsets) to contain an underspecified consonant [$X^{(j)}$] in Scottish Gaelic. Accordingly, I assume that forms such as those in (13) contain an underlying cluster of a sonorant + /$X^{(j)}$/, e.g. *Aonghas* /XɯnXəs/ ‘Angus’. I regard a cluster as heterorganic whenever both consonants bear non-identical primary place features, including when one of them is unspecified for place (note that svarabhakti can occur before placeless [h], e.g. *onfhadh* [ɔnɔ́həɣ] ‘stormy sea’). An underlying cluster of a sonorant + /$X^{(j)}$/ is thus heterorganic and is broken up by svarabhakti in the usual manner. Svarabhakti in these forms therefore does not display overapplication at all, but rather reflects covert phonological structure.

Secondly, another set of forms exists in which svarabhakti underapplies before [h]:

(14)	*ceathrair*	[kʲʰɛ́rhərʲ]	*[kʲʰɛrɛ́hərʲ]	‘four.PERS’
	cothrom	[kʰɔ́rhəm]	*[kʰɔrɔ́həm]	‘weight’
	creithleag	[kʰrʲélʲhak]	*[kʰrʲelʲéhak]	‘horsefly’
	iothlainn	[i̯úLhiNʲ]	*[i̯uLúhiNʲ]	‘cornyard’

However, there is clear independent evidence for a phrase-level process that metathesises underlying /h/ + sonorant clusters in Scottish Gaelic. This metathesis can be seen affecting the word-initial clusters /t̪ʰr sN ʃNʲ sL ʃLʲ sR/ when they undergo the *lenition* mutation (*see* ch. 5, §5.2.2) in some of the dialects of Skye described by

Borgstrøm (1941: 41–42). In the dialects in question, these clusters normally become [hr hn hn hL hl^{j} hr] respectively under lenition but are metathesised to [rh] etc. when preceded by a vowel. In Lewis, the lenited grades of word-initial /s∼ʃ/ + sonorant clusters do not contain [h], but Oftedal (1956: 162) reports for Leurbost exactly the same alternation between [hr] and [rh] in the lenited grade of /t̪^{h}r/, and this is confirmed by my own observations in Ness.[8] I therefore assume that the forms in (14) contain an underlying cluster of /h/ + sonorant, e.g. *ceathrair* /k^{jh}ɛhrər^{j}/ 'four.PERS', and that svarabhakti is counterfed by this phrase-level metathesis.[9]

Once these two sets of forms are accounted for, there remain in the Lewis data a small number of forms in which svarabhakti appears to misapply. First of all, for Leurbost Gaelic, Oftedal (1956: 239) notes that a svarabhakti vowel may occur word-finally in two common verbs. These verbs both display final [v] when a vowel-initial word follows, but not elsewhere:

(15)

	Before V	Elsewhere	
falbh	[faLáv]	[faLá]	'leave'
marbh	[maráv]	[mará]	'kill'

Only the forms with [v] are reported for Bernera and Ness. I assume that these two verbs underlyingly contain a floating final /v/ in Leurbost, i.e. /faL(v)/, /mar(v)/, which triggers svarabhakti yet is itself realised only when followed by a vowel-initial word. "Liaison" consonants like this are not unprecedented in Scottish Gaelic and occur frequently in function words, where I refer to them as *prothetic* consonants (*see* ch. 5, §5.2.3).[10] Secondly, the form *toirbhsgeir* [t̪^{h}aráʃk^{j}ər] 'peat-iron' displays a svarabhakti vowel between two coronal consonants [r] and [ʃ]. This form reflects a borrowing of Old Norse *torfskeri*, containing the sequence /rvs/ (Oftedal 1956: 55), which leads Smith (1999: 598–599) to propose that /v/ is still present underlyingly in the Scottish Gaelic form, i.e. /t̪^{h}arvʃk^{j}ər/. Although there is no independent evidence for

[8]Borgstrøm (1940: 73) also reports the alternation for Bernera, but says nothing of its conditioning.

[9]In fact, I suspect that these sonorant + [h] clusters may really be breathy-voiced sonorants in the phonological surface representation, similar to the breathy-voiced nasals of Lewis Gaelic described in ch. 1, §1.2.1. If this is correct, then the forms in (14) do not show underapplication of svarabhakti in the first place.

[10]The absence of [v] in the suffixed forms *falbhaidh* [faLá-i] 'leave-NPST' and *marbhaidh* [mará-i] 'kill-NPST', which appear above in (13), must point to a suppletive stem allomorph in final /X/ rather than final floating /v/, since there is no general word-level ban on [v] in this position (*cf. sealbhach* [ʃaLávəx] 'lucky', from *sealbh* [ʃaLáv] 'luck' + the adjectival suffix *-(e)ach* [-əx]).

underlying /v/ in this particular form, there is certainly evidence for a synchronic process that deletes /v/ before obstruents at some stage in the phonological derivation, e.g. *meanbh* [mɛnɛ́v] ‘tiny’ but *meanbh-chuileag* [ˈmɛnɛ́ˌxulʲak] ‘midge’ (lit. ‘tiny fly’).[11] Finally, the form *cainb* [kʰanáʰp] ‘hemp’, reported by Oftedal (1956) for Leurbost, displays a svarabhakti vowel between a lenis sonorant and a pre-aspirated stop. This is the one form in the Lewis data that we can say with certainty is truly irregular, and we will return to it in §4.4.4.

4.3.3 /ə/-syncope and svarabhakti

Svarabhakti interacts in an interesting manner with a phenomenon of stem-internal /ə/-syncope that often affects suffixed forms. In Scottish Gaelic, many stems display an alternation between a disyllabic allomorph with [ə] (or its conditioned allophone [i] before certain slender consonants) in the second syllable and a syncopated monosyllabic allomorph without. The disyllabic allomorph occurs in unsuffixed forms and the monosyllabic one when a vowel-initial suffix is present:

(16)	*bleoghainn*	[plʲɔ́iNʲ]	‘milk’	NPST	*bleòghnaidh*	[plʲɔ̆ːn-i]
	caraid	[kʰárətʲ]	‘friend’	PL	*càirdean*	[kʰăːt̪ˠ-ən]
	muilinn	[múlʲiNʲ]	‘mill’	PL	*muilnean*	[məíLʲ-ən]
	tachair	[t̪ʰáxərʲ]	‘happen’	NPST	*tachraidh*	[t̪ʰáxr-i]

The alternations accompanying /ə/-syncope are often highly complex. Interestingly, [ə] (or [i]) can also alternate with a svarabhakti vowel in exactly those cases where syncope would bring about a cluster of the type targeted by svarabhakti:

(17)	*aithnich*	[ánixʲ]	‘know’	NPST	*aithnchidh*	[anáxʲ-i]
	balach	[páLəx]	‘boy’	PL.VOC	*bhalchaibh*	[vaLáx-u]
	fairich	[fárʲixʲ]	‘feel’	NPST	*fairchidh*	[farʲáxʲ-i]
	fuiling	[fúlʲikʲ]	‘suffer’	NPST	*fuilngidh*	[fulʲúkʲ-i]

Although a number of authors treat /ə/-syncope as a synchronically productive process (Bosch 1994; Smith 1999; Hall 2003; Iosad 2015), certain stems do not undergo the process in Lewis Gaelic:

[11] The same historical explanation, and synchronic underlying representation, would also account for the village names *Tolastadh* [t̪ʰɔLɔ́st̪aɣ] ‘Tolsta’ and *Torastaidh* [t̪ʰarást̪aj] ‘Torastay’ reported in Oftedal (1954: 378, 403).

(18) *cuisill* [kʰúʃiLʲ] 'blood vessel' PL *cuisillean* [kʰúʃiLʲ-ən]
freagair [frɤ̃kərʲ] 'answer' NPST *freagairidh* [frɤ̃kərʲ-i]

Given the lexically specific nature of the phenomenon, I assume that no synchronic phonological process is involved. Instead, I propose that the forms in (16) and (17) have stems represented lexically by two listed allomorphs, e.g. *tachair* /{t̪ʰaxərʲ,t̪ʰaxr}/ 'happen', *fairich* /{farʲixʲ,farʲxʲ}/ 'feel', and that the disyllabic allomorph is selected in unsuffixed forms and the monosyllabic allomorph in suffixed forms. If a form such as *fairchidh* [farʲáxʲ-i] 'feel-NPST' is derived from a monosyllabic stem allomorph /farʲxʲ/, then svarabhakti is predicted to occur in the usual manner.

4.4 Stem-level weight-by-position

In preparation for a discussion of the derivation of svarabhakti groups, this part of the analysis examines the moraicity of coda consonants at the stem level in Lewis Gaelic. By considering svarabhakti in parallel with a process of *lengthening* that affects vowels before tautosyllabic fortis sonorants, I offer a unified account in which both processes occur in the word-level phonology and make use of morae headed by coda sonorants in the stem-level output. I propose that coda sonorants are subject to weight-by-position (henceforth WBP; Hayes 1989) at the stem level under certain circumstances. Although these morae are subsequently transferred onto adjacent vowels at the word level in Lewis Gaelic, I show that the stem-level representations proposed here are directly observable in other dialects in which lengthening and/or svarabhakti do not occur. Only stressed syllables are considered, since lengthening and svarabhakti do not affect unstressed syllables. §4.4.1 considers stem-final sonorants, §4.4.2 considers stem-internal sonorants before pre-aspirated stops, and §4.4.3 considers stem-internal sonorants before other consonant types. §4.4.4 provides a summary, and shows how the system of stem-level WBP proposed here correctly predicts a particular case of underapplication of svarabhakti in certain non-Lewis dialects, as well as the existence of exceptional items like *cainb* [kʰanáʰp] 'hemp' in Lewis.

4.4.1 Stem-final sonorants

In Lewis Gaelic, monosyllabic stems ending in fortis sonorants display alternations whereby the sonorant is preceded by a long vowel or diphthong when in the coda, and by a short vowel when resyllabified into the onset:

(19) *caill* [kʰaíLʲ] 'lose' NPST *caillidh* [kʰáLʲ-i]
cùm [kʰɔúm] 'hold' VN *cumail* [kʰúm-alʲ]
geàrr [kʲăːR] 'cut' VN *gearradh* [kʲáR-əɣ]
pronn [pʰrɔúN] 'mash' VN *pronnadh* [pʰrɔ́N-əɣ]

Diphthongs ending in [u] occur before [N L], diphthongs ending in [i] before [Nʲ Lʲ], and long monophthongs before [R]; all three may occur before [m] depending on circumstances that need not be discussed here. Forms such as *ceannard* [kʲʰaúNət̪ˠ] 'chief' and *gàrradh* [kăːRəɣ] 'wall' show that there is no general shortening process in this position, and note also the direction of neutralisation of the vowels in *cùm* and *pronn*. I therefore assume that these forms contain a short vowel underlyingly, e.g. *caill* /kʰaLʲ/ 'lose', and that a word-level phonological process triggers lengthening or diphthongisation of an underlying short vowel before a tautosyllabic fortis sonorant. For simplicity I will refer to this process as *lengthening*, since the qualitative distinction between long vowels and diphthongs is not relevant to us here.

Lengthening displays underapplication under certain circumstances. First of all, recall from §4.1.1 that word-level fortition processes convert certain underlyingly lenis coronal sonorants into fortis ones. These processes fail to feed lengthening:

(20) a. Fortis [Nʲ] from slenderisation of lenis /n/
buin [púN̥ʲ] *[pəíNʲ] 'base.GEN' (*cf.* NOM *bun* [pún̥])
coin [kʰɔ́N̥ʲ] *[kʰəíNʲ] 'dog.GEN' (*cf.* PL.GEN *chon* [xɔ́n̥])

b. Fortis [L] from lenis /l/
geal [kʲáL̥] *[kʲaúL] 'white' (*cf.* CMP *gile* [kʲílʲ-ə])
mol [mɔ́L̥] *[mɔúL] 'shingle' (*cf.* GEN *muile* [múlʲ-ə])

Additionally, another word-level fortition process converts lenis /n/ into fortis [N] before a coronal stop. This process also fails to feed lengthening:

(21) *bean* [pɛ́n̥] 'touch' VN *beantainn* [pɛ́N-t̪iNʲ] *[pɛ̯aúN-t̪iNʲ]

can [kʰḁ́n̥] 'say' VN *cantainn* [kʰáN-t̪iNʲ] *[kʰaúN-t̪iNʲ]

Here we seem to have what is effectively a chain shift in the word-level phonology: various fortition processes trigger [Vn$^{(j)}$ Vl] → [VN$^{(j)}$ VL] while lengthening triggers [VN$^{(j)}$ VL] → [V:N$^{(j)}$ V:L], but the former fails to feed the latter. At first glance, this is highly problematic for an Optimality Theoretic analysis. Simply being fortis is not enough to guarantee that a stem-final coda sonorant triggers lengthening in the word-level output: apparently, lengthening may only occur if the sonorant was already fortis in the word-level input. The simplest solution to this paradox – assuming only traditional Optimality Theoretic markedness and faithfulness constraints – is to propose that there is in fact no chain shift at all, and that stem-final fortis coda sonorants exit the stem-level phonology bearing some additional marking besides whatever featural properties are responsible for the fortis–lenis contrast in general. Evidence from other dialects of Scottish Gaelic suggests that this additional marking is a mora.

In parts of Argyll, such as Islay (Grannd 1985; 2000) and Jura (Jones 2000; 2006; 2010), lengthening does not occur before stem-final fortis coda nasals and laterals (for simplicity, historically fortis rhotics – which do trigger lengthening – will be set aside here). Instead, they are geminated when (underlyingly) fortis but not when lenis (all Islay forms in this section are from *SGDS*):

(22) **Lewis** **Islay**

a. Fortis nasal or lateral

cam	[kʰaúm]	[kʰɛmː]	'crooked'
seinn	[ʃeíNʲ]	[ʃeNʲː]	'sing'
toll	[t̪ʰɔúL]	[t̪ʰoLː]	'hole'
tuill	[t̪ʰəíLʲ]	[t̪ʰuLʲː]	'hole.GEN'

b. Lenis nasal or lateral

bean	[pɛ́n̥]	[pen]	'wife'
coin	[kʰɔ́N̥ʲ]	[kʰɔNʲ]	'dog.GEN' (*cf.* Lewis PL.GEN *chon* [xɔ́n̥])
fuil	[fúl̥ʲ]	[fulʲ]	'blood'
geal	[kʲáL̥]	[kʲaL]	'white' (*cf.* Lewis CMP *gile* [kʲílʲ-ə])

Islay Gaelic therefore displays an overtly moraic sonorant wherever Lewis displays lengthening of the preceding vowel. I propose that – ignoring occasional differences in segmental quality – the Lewis stem-level outputs for the forms in (22a) are in fact identical to the Islay surface forms: specifically, stem-final fortis sonorants are subject to WBP in the stem-level phonology, thus rendering them moraic, while lenis ones are not. The crucial difference between the two dialects is that Lewis Gaelic has a word-level phonological process that subsequently transfers a mora from a moraic coda sonorant onto a preceding tautosyllabic vowel, triggering lengthening, while Islay Gaelic does not. I assume that if the sonorant is resyllabified into an onset at the word level, as occurs before a vowel-initial suffix, then this mora is lost. This approach allows us to account for the lengthening alternations in (19) as well as the paradoxical underapplication of lengthening in (20) and (21), while simultaneously reducing the difference between the Lewis and Islay forms in (22a) to the presence of a word-level mora-transfer process in the former dialect but not the latter. Note that what I propose here is effectively a stratal version of Ní Chiosáin's (1991) analysis of the cognate phenomenon in Irish. The qualitative fortis–lenis distinction has been lost in the Irish variety in question, but historically fortis stem-final sonorants trigger lengthening alternations similar to those in (19). Ní Chiosáin analyses these sonorants as lexically moraic, and this mora is either transferred or lost just as I claim occurs at the word level in Lewis Gaelic.

When a stem-final fortis sonorant is preceded by an underlying long vowel or diphthong, no lengthening occurs in Lewis and no gemination occurs in Islay. In the following forms, the quality of the preceding long vowel or diphthong indicates that it is not the product of lengthening:

(23)

	Lewis	Islay	
màm	[mǎːm]	[mɛːm]	'lump'
Niall	[Nʲiə́L]	[NʲiaL]	'Neil' (*cf.* Lewis GEN *Nèill* [něːLʲ])

Since Islay Gaelic realises moraic coda consonants as geminates, the final sonorant in these Islay forms cannot be moraic. I therefore assume that stem-level WBP is blocked when the preceding vowel is dimoraic, which can be accounted for by common constraints against superheavy syllables. We can therefore now make the following generalisation about stem-final sonorants:

(24) When stem-final, fortis coda sonorants (but not lenis ones) are subject to WBP

at the stem-level, unless this would result in a superheavy syllable.

In the following sections, we will build upon this generalisation in order to include stem-internal coda sonorants.

4.4.2 Stem-internal sonorants before pre-aspirated stops

When followed by a pre-aspirated stop, stem-internal fortis and lenis sonorants behave in different ways in Lewis Gaelic. If the cluster is homorganic, various phonotactic restrictions mean that it is possible to independently distinguish between underlyingly fortis and lenis sonorants only in the case of the laterals (through slenderisation alternations). The effects of lengthening can be observed before (underlyingly) fortis laterals, while lenis laterals may freely be preceded by a short vowel (recall that pre-aspiration is realised as devoicing of any preceding sonorant):

(25) a. Fortis lateral + homorganic pre-aspirated stop

allt [aúL̥t̪] 'stream' GEN *uillt* [əíL̥ʲtʲ]

b. Lenis lateral + homorganic pre-aspirated stop

alt [áL̥t̪] 'joint' GEN *uilt* [úl̥ʲtʲ]

Meanwhile, if the cluster is heterorganic, recall from §4.3.1 that svarabhakti occurs if the sonorant is (underlyingly) fortis but not if it is lenis:

(26) a. Fortis sonorant + heterorganic pre-aspirated stop

currcag [kʰuRúʰkak] 'lapwing'

b. Lenis sonorant + heterorganic pre-aspirated stop

cearc	[kʲʰɛ́r̥k]	'hen'
corp	[kʰɔ́r̥p]	'body'
olc	[ɔ́L̥k]	'evil' (*cf.* GEN *uilc* [úl̥ʲkʲ])
peirceall	[pʰér̥ʲkʲəL]	'jaw'

These forms reveal an important parallel between lengthening and svarabhakti. Both processes occur before a pre-aspirated stop only if the sonorant is fortis, with the choice between the two determined by whether the cluster is homorganic or heterorganic. This complementary relationship suggests that a similar mechanism lies behind both processes, allowing us to generalise the mora-transfer analysis from lengthening to svarabhakti. In order to provide a maximally simple and unified account of the two processes, I therefore propose that svarabhakti represents a word-level mora transfer process just like lengthening, and thus may only occur if the sonorant is moraic in the stem-level output. Since I have assumed that a constraint against superheavy syllables blocks WBP when the preceding vowel is dimoraic, this approach also captures the fact that svarabhakti never occurs after a long vowel or diphthong. Note that this analysis is again similar to that proposed for the cognate phenomenon in Irish by Ní Chiosáin (1991), who also recognises a link between svarabhakti and lengthening (*see also* Ó Baoill 1981, who discusses this link from a diachronic perspective, and Cyran 1996, who unifies the two phenomena in a Government Phonology framework). According to her rule-based analysis, sonorants are subject to WBP under certain conditions, and this mora is subsequently transferred to a svarabhakti vowel. Similarly, Hall's (2003) analysis also considers svarabhakti to be dependent upon the moraicity of a coda sonorant. We can therefore now amend the generalisation in (24) as follows, in order to include stem-internal sonorants before pre-aspirated stops:

(27) When stem-final or followed by a pre-aspirated stop, fortis coda sonorants (but not lenis ones) are subject to WBP at the stem-level, unless this would result in a superheavy syllable.

4.4.3 Stem-internal sonorants before other consonant types

When the following consonant is not a pre-aspirated stop, stem-internal fortis and lenis sonorants both behave in the same way in Lewis Gaelic. If the cluster is homorganic, only fortis sonorants are found, and the effects of lengthening can again be observed (recall from ch. 1 that a velarised retroflex consonant can be assumed to represent underlying /R/ + coronal in Lewis Gaelic):

(28) Fortis sonorant + homorganic consonant

àrd	[ǎːʈˠ]	'high'
bùrn	[pǔːɳˠ]	'water'
punnd	[pʰəúNt̪]	'pound'
soillseachadh	[səíLʲʃəxəɣ]	'shine.VN'

Meanwhile, if the cluster is heterorganic, recall from §4.3.1 that svarabhakti occurs regardless of whether the sonorant is (underlyingly) fortis or lenis:

(29) a. Fortis sonorant + heterorganic consonant

crannchar [kʰraNáxər] 'fate'

fairrge [faRákʲə] 'rough sea'

imleag [imílʲak] 'navel'

b. Lenis sonorant + heterorganic consonant

balg [paLák] 'bag' (*cf.* GEN *builg* [pulʲúkʲ])

dorgh [t̪ɔrɔ́ɣ] 'fishing line'

failm [fɤlʲɤ́m] 'helm'

seanmhair [ʃɛnɛ́varʲ] 'grandmother'

A maximally simple and unified account of lengthening and svarabhakti therefore requires that *all* stem-internal coda sonorants – not just fortis ones – are subject to stem-level WBP when followed by a consonant that is not a pre-aspirated stop (unless this would result in a superheavy syllable). We can therefore amend the generalisation in (27) as follows, in order to include stem-internal sonorants before other consonant types:

(30) a. When stem-final or followed by a pre-aspirated stop, fortis coda sonorants (but not lenis ones) are subject to WBP at the stem-level;

b. When followed by a consonant that is not a pre-aspirated stop, all coda sonorants are subject to WBP at the stem-level;

Unless, in either case, this would result in a superheavy syllable.

This generalisation now covers all coda sonorants in Lewis Gaelic.[12] We therefore have the following stem-level outputs for forms such as those in (12):

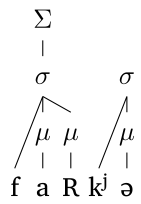
[12] The somewhat marginal cluster [ŋk] is exceptional in that it may freely be preceded by a short vowel, e.g. *Frangach* [fraŋ́kəx] 'French', in spite of the fact that the nasal should be moraic in the stem-level output according to (30). Given the position of the pitch peak, which is based on my own impression of the pronunciation of forms of this type in Ness, I assume that the nasal is indeed subject to stem-level WBP as expected, but that word-level mora transfer simply does not affect [ŋ]. The nasal therefore remains moraic on the surface, and accordingly bears the second-mora pitch peak of C2. The analysis of forms like this as containing a dimoraic syllable, despite the vowel being short, is supported by the fact that under slenderisation they alternate with forms that contain a diphthong and are thus clearly dimoraic, e.g. *an Fhraing* [ə raíŋʲkʲ] 'France'.

If [ʂˠ] in e.g. *farsaing* [fáʂˠikʲ] 'wide' is taken to represent underlying /Rs/, in parallel with other velarised retroflex consonants, then this cluster is likewise exceptional. However, there is no clear evidence for the synchronic underlying representation of this sound. It could be speculated that /ʂˠ/ is in fact present underlyingly, or that the fusion of underlying /Rs/ to [ʂˠ] takes place at the stem level – either of which would mean that there is no coda sonorant in the stem-level output.

(31) If

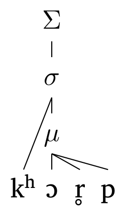
a. the sonorant is preceded by a short vowel, and

  i. the sonorant is fortis → the sonorant is moraic

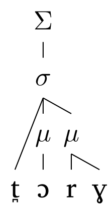


  ii. the sonorant is lenis, and

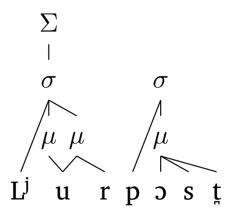
    A. the other consonant is a pre-aspirated stop → the sonorant is not moraic



    B. the other consonant is not a pre-aspirated stop → the sonorant is moraic



b. the sonorant is preceded by a long vowel or diphthong → the sonorant is not moraic



In §4.5 it will be shown how the observed surface forms are derived from these stem-level outputs.

Importantly, this analysis leads us to expect that any dialect lacking svarabhakti will display a moraic coda sonorant on the surface wherever svarabhakti occurs in Lewis Gaelic. It will therefore now be useful to look at the dialect of East Perthshire described by Ó Murchú (1989), in which svarabhakti does not occur. This dialect differs from that of Lewis in several important ways. First of all, the qualitative fortis–lenis distinction has been lost in the variety described, but historically fortis stem-final nasals and laterals are realised as geminates – i.e. they are overtly moraic – when in coda position while historically lenis ones are not (again for simplicity, historically fortis rhotics will be set aside here):[13]

(32) **Lewis** **E. Perths.**

a. Fortis nasal or lateral

cam	[kʰaúm]	[kʰamː]	'crooked'
seinn	[ʃeíNʲ]	[ʃenʲː]	'sing'
toll	[t̪ʰɔúL]	[t̪ʰolː]	'hole'
tuill	[t̪ʰəíLʲ]	[t̪ʰulʲː]	'hole.GEN'

b. Lenis nasal or lateral

bean	[pɛ́n̥]	[pɛn]	'wife'
coin	[kʰɔ́N̥ʲ]	[kʰɔnʲ]	'dog.GEN' (*cf.* Lewis PL.GEN *chon* [xɔ́n̥])
fuil	[fúl̥ʲ]	[fulʲ]	'blood'
geal	[kʲáL̥]	[kʲal]	'white' (*cf.* Lewis CMP *gile* [kʲílʲ-ə])

The fact that this variety has preserved the historical fortis–lenis contrast stem-finally by means of lexically contrastive moraicity suggests an earlier diachronic stage at which stem-final fortis coda sonorants were obligatorily moraic while lenis ones were not, just as is observed on the surface in present-day Islay Gaelic and just as I propose in (30) for the stem-level output in Lewis.

Secondly, pre-aspiration has been lost in East Perthshire, but the historical contrast between plain and pre-aspirated stops is reflected in the moraicity of a preceding historically lenis sonorant. Historically pre-aspirated stops are preceded by singleton sonorants, and historically plain stops by geminate sonorants (where Lewis Gaelic displays svarabhakti):

[13] Ó Murchú's (1989) description is primarily based on a single speaker. Comparison with *SGDS* data shows that this speaker is located at the eastern edge of a dialect area, centered on North Argyll and West Perthshire, in which a complex mixture of coronal nasal systems are found. The two-way nasal system displayed by this speaker, with /N=n/ vs. /Nʲ=nʲ/, is therefore not characteristic of the dialect in general. On the other hand, the two way lateral system displayed by this speaker, with /L=l/ vs. /Lʲ=lʲ/, is strongly characteristic of the same area. Immediately to the east, in the remainder of East Perthshire, the tendency is towards two-way systems of a different type, with /N=n=nʲ/ vs. /Nʲ/ and /L=l=lʲ/ vs. /Lʲ/, although one East Perthshire speaker (pt. 194) displays a full four-way lateral system.

(33) **Lewis** **E. Perths.**

a. Lenis sonorant + pre-aspirated stop

corp	[kʰɔ́r̥p]	[kʰɔrp]	'body'
olc	[ɔ́L̥k]	[ɔlk]	'evil' (*cf.* Lewis GEN *uilc* [úl̥ʲkʲ])

b. Lenis sonorant + plain stop

balg	[paLák]	[pal:k]	'bag' (*cf.* Lewis GEN *builg* [pulʲúkʲ])
earball	[ɯrɯ́pəL]	[i̯ar:pəl]	'tail'

This suggests an earlier diachronic stage at which lenis coda sonorants were obligatorily moraic before plain stops but not before pre-aspirated stops, which is again in accordance with what I propose in (30) for the stem-level output in Lewis.

Finally, historically lenis sonorants are always geminate before other consonant types (where Lewis displays svarabhakti):

(34) Lenis sonorant + consonant

	Lewis	**E. Perths.**	
ainm	[anám]	[ɛn:m]	'name'
dorcha	[t̪ɔrɔ́x]	[t̪ɔr:x]	'dark'
seanmhair	[ʃɛnɛ́varʲ]	[ʃɛn:war]	'grandmother'
suirghe	[sɯrʲɯ́j]	[sur:j]	'court.VN'

Lenis coda sonorants are therefore obligatorily moraic before other consonant types, which yet again agrees with what I propose in (30) for the stem-level output in Lewis. The moraicity of coda sonorants in East Perthshire Gaelic thus exactly matches what I propose for the stem-level output in Lewis in every single case.

4.4.4 Summary

To summarise, I have argued that stem-level WBP in Lewis Gaelic affects coda sonorants according to the generalisation in (30). Certain aspects of this system are typologically unsurprising. Sonorants are the only consonants that show any evidence of being moraic at the stem level in Lewis Gaelic, which is consistent with the fact that WBP tends to target coda consonants that exceed a language-specific threshold of sonority (Zec 1995; Morén 1999). I assume that the blocking of WBP on a stem-final lenis coda sonorant is due to a constraint against moraic consonants in final position. The blocking of WBP on a lenis coda sonorant before a pre-aspirated stop remains unknown, but note that this also appears to correlate with sonority, since pre-aspirated stops can be considered the least sonorous segments in the language.[14] Although the featural content of the fortis–lenis contrast is unclear, I assume that these blocking processes are overridden by a stem-level requirement for fortis sonorants to project a mora wherever possible. Coupled with an undominated constraint against superheavy syllables, this brings about the observed system.

By ascribing the blocking of svarabhakti between a lenis sonorant and a pre-aspirated stop to the absence of an available mora in the stem-level output, the present analysis correctly predicts the behaviour of a particular set of forms that display underapplication of svarabhakti in a number of non-Lewis dialects. Where Lewis Gaelic has a contrast between pre-aspirated /ʰk/ and a cluster /xk/, dialects such as that of Barra instead merge both to [xk] (Borgstrøm 1937; 1940):

(35)

		Lewis	**Barra**	
a.	[ʰk] in Lewis∼[xk] in Barra			
	breac	[prʲéʰk]	[prʲɛ́xk]	‘speckled’
	cnoc	[kʰrɔ́ʰk]	[kʰrɔ́xk]	‘hill’
b.	[xk] in both Lewis and Barra			
	bochd	[pɔ́xk]	[pɔ́xk]	‘poor’
	seachd	[ʃɛ́xk]	[ʃɛ́xk]	‘seven’

In Lewis, stem-final /ʰk/ is capable of undergoing slenderisation (to [ʰkʲ]) but /xk/ is immune to the process (Borgstrøm 1940: 84, Oftedal 1956: 172). Meanwhile, in Barra, stems ending in [xk] take part in slenderisation alternations (with [xʲkʲ]) only when this corresponds to Lewis /ʰk/, and not when it corresponds to Lewis /xk/ (Borgstrøm 1940: 175), e.g. Barra *bhric* [vrʲíxʲkʲ] ‘speckled.M.GEN’ but *bhochd* [vɔ́xk] ‘poor.M.GEN’. Since the distinction is evidently visible to inflectional processes, I assume that /ʰk/ and /xk/ both exist underlyingly in Barra and remain distinct until the word-level

[14] A speculative possibility is that the blocking of WBP here is due to the fact that sonorant is devoiced in this position, since voiceless segments have lower sonority than voiced ones. However, this would require devoicing to have already occured at the stem level. What little evidence exists for the stratal affiliation of this devoicing suggests that it occurs later in the derivation, since it can be fed by suffixation, e.g. *baile* [pálʲə] ‘town’, plural *bailtean* [pál̥ʲ-tʲən], *sgìre* [skʲĭːrʲə] ‘parish’, plural *sgìrtean* [skʲĭːr̥ʲ-tʲən] (where the final [-ə] of these stems might be considered a thematic suffix with a zero allomorph in the plural).

phonology. The present analysis correctly predicts that svarabhakti will underapply in Barra when a lenis sonorant is followed by an instance of [xk] that may undergo slenderisation:

(36) **Barra** (Borgstrøm 1937)

cearc	[kʲʰɛ́rxk]	*[kʲʰɛrɛ́xk]	'hen'	PREP	*circ*	[kʲʰírʲxʲkʲ]	*[kʲʰirʲíxʲkʲ]
olc	[ɔ́Lxk]	*[ɔLɔ́xk]	'evil'	GEN	*uilc*	[úlʲxʲkʲ]	*[ulʲúxʲkʲ]

This is because a lenis coda sonorant is not subject to stem-level WBP when followed by an underlyingly pre-aspirated stop such as /ʰk/. Since the sonorant is not moraic in the word-level input, svarabhakti is blocked, even though word-level insertion of [x⁽ʲ⁾] after the sonorant brings about the surface conditions under which svarabhakti is normally observed. A stratal analysis such as this, in which both svarabhakti and lengthening are word-level processes that make use of morae projected by stem-level coda sonorants under certain conditions, is therefore able to account for instances of opacity not only in Lewis Gaelic but in other dialects of Scottish Gaelic as well.

Since the stem-level phonology assigns morae to coda sonorants under well-defined circumstances, the present analysis offers no means by which a sonorant could possibly fail to be moraic in the stem-level output if it meets the conditions for stem-level WBP. This leads to the prediction that all cases of underapplication of lengthening or svarabhakti in Lewis Gaelic can be ascribed to the counterfeeding effects of independently motivated post-stem-level processes. Sure enough, the underapplication of lengthening before derived fortis sonorants in (20) and (21) can be ascribed to word-level fortition processes, while the underapplication of svarabhakti in sonorant + [h] clusters in (14) can be ascribed to a phrase-level process of metathesis. However, this analysis does not exclude the possibility that coda sonorants may be exceptionally moraic under certain circumstances. If the faithfulness constraints protecting underlyingly moraic coda sonorants are ranked sufficiently high in the stem-level phonology, then a sonorant might be moraic in the stem-level output despite not fulfilling the conditions for stem-level WBP. The form *cainb* [kʰanáʰp] 'hemp', mentioned in §4.3.2, is an example of exactly the type of exception that would be predicted to occur. Although a lenis sonorant does not automatically become moraic at the stem level when followed by a pre-aspirated stop, it can be assumed that /n/ in this form is underlyingly moraic and that the relevant markedness and faithfulness constraints are ranked in such a way as to ensure that it remains moraic in the stem-level output. This allows svarabhakti to occur at the word level in this form. The present analysis is therefore able to account for exactly the type of misapplication of svarabhakti that occurs in the Lewis data, while simultaneously disallowing phenomena that are never observed to occur.

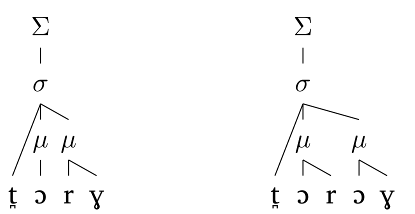
4.5 The derivation of svarabhakti groups

This part of the analysis offers an Optimality Theoretic account of the derivation of svarabhakti groups in the word-level phonology of Lewis Gaelic, showing how the surface structures established in §4.2 for svarabhakti forms are derived from the stem-level outputs proposed in §4.4. §4.5.1 discusses forms in which svarabhakti occurs in order to break up a heterorganic cluster and §4.5.2 discusses cases in which it is blocked. §4.5.3 discusses cases involving the interaction of svarabhakti with /ə/-syncope.

4.5.1 Occurrence of svarabhakti

According to the analysis so far, a svarabhakti form such as *fairrge* [faRákʲə] 'rough sea' or *dorgh* [t̪ɔrɔ́ɣ] 'fishing line', underlyingly /faRkʲə/ and/t̪ɔrɣ/ respectively, has the stem-level output shown in (31) and a surface form similar to that of *balg* [paLák] 'bag' in (11). It was proposed in §4.4 that svarabhakti is a word-level process that transfers a mora from a coda sonorant onto an epenthetic vowel. Taking *dorgh* as an example, such a form therefore has the following word-level input and output:

(37) Word-level input: Word-level output:



The input syllable count is preserved when svarabhakti occurs, so that the entire svarabhakti group remains monosyllabic. This is in spite of the fact that it is generally assumed that faithfulness constraints cannot directly refer to input syllable structure (e.g. McCarthy 2002: 73–74). In order to account for this, I borrow insights from Köhnlein (2016; 2018a), who proposes that the foot head is located at the highest level of metrical representation at which the foot displays binarity: in a foot containing two syllables (a syllabic trochee) the head is the first syllable, while in a foot containing one dimoraic syllable (a moraic trochee) the head is the first mora. To illustrate, the foot head is circled in both cases:

(38) Syllabic trochee: Moraic trochee:

Secondly, I follow Köhnlein (2011; 2016; 2018a; *see also* McCarthy 1995; 2000) in assuming that metrical heads are subject to faithfulness. I therefore define a constraint HEADMATCH(Σ) as follows, adapted from Köhnlein (2011: 187; 2016: 98; 2018a: 630):

(39) HEADMATCH(Σ): Let Σ_I be a foot in the input and let Σ_O be its output correspondent. Assign a violation mark if the head of Σ_O is not the output correspondent of the head of Σ_I.

When highly ranked, this constraint can drive faithfulness to input syllable count by ensuring that a monosyllabic foot does not become disyllabic and vice versa.

This part of the analysis also assumes the following constraints, all of which are common in the phonological literature:

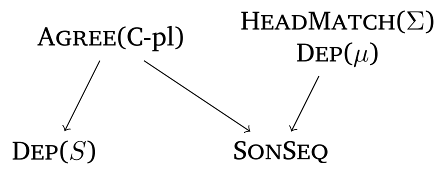
(40) AGREE(C-pl): Let C_1C_2 be a sequence of two consonants in the output. Assign a violation mark if there exists a C-place feature F such that F is linked to C_1 but not C_2 *or* F is linked to C_2 but not C_1.

(41) DEP(μ): Let μ be a mora in the output. Assign a violation mark if μ does not have an input correspondent.

(42) DEP(S): Let S be a segment in the output. Assign a violation mark if S does not have an input correspondent.

(43) SONSEQ: Let σ be a syllable in the output. Assign a violation mark if σ contains more than one sonority peak.

(44)



Since svarabhakti targets heterorganic clusters, I assume that it is driven by Agree(C-pl). If we rank Agree(C-pl) above Dep(S), and Agree(C-pl), HeadMatch(Σ) and Dep(μ) above SonSeq, as in (44), then we obtain the observed result for the word-level input established in (31) for *dorgh* [t̪ɔrɔ́ɣ] 'fishing line'. This is shown in the tableau in (45). The fully faithful candidate (a) violates high-ranked Agree(C-pl) due to the presence of a heterorganic cluster, forcing epenthesis to occur in violation of low-ranked Dep(S).[15] However, if the svarabhakti vowel were to project a syllable of its own (b) then this would incur a violation of high-ranked HeadMatch(Σ). The entire svarabhakti group therefore remains monosyllabic (c) in violation of both Dep(S) and low-ranked SonSeq. An alternative repair (d), in which the svarabhakti vowel projects a syllable of its own but the first syllable remains dimoraic in order to satisfy HeadMatch(Σ) is blocked by high-ranked Dep(μ) because it requires the insertion of a mora.

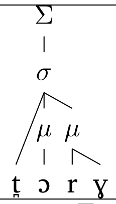
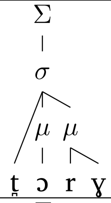
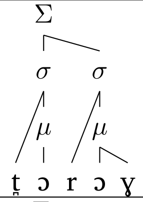
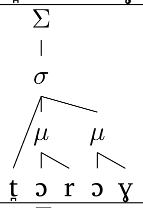
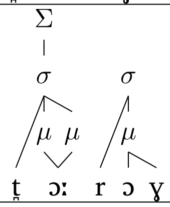
4.5.2 Blocking of svarabhakti

Recall from §4.3.1 that svarabhakti fails to occur in a cluster of a sonorant + a heterorganic consonant under two conditions: (i) the sonorant is lenis and the other consonant is a pre-aspirated stop; or (ii) the sonorant is preceded by a long vowel or a diphthong. In §4.4 I proposed that this is because a coda sonorant is not subject to stem-level WBP in either of those positions. The coda sonorant in forms such as *corp* [kʰɔ́r̥p] 'body' and *Liùrbost* [Lʲŭːrpɔst̪] 'Leurbost', underlyingly /kʰɔrʰp/ and /Lʲu$_{\mu\mu}$rpɔst̪/ respectively, is therefore non-moraic in the word-level input, and the form is unchanged in the word-level output.

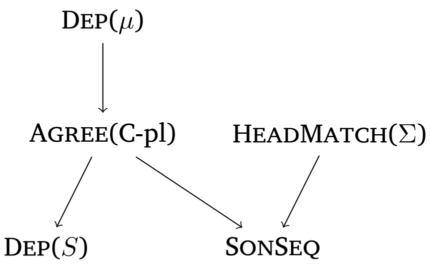
I assume that Dep(μ) is responsible for the blocking of svarabhakti in forms in which the sonorant is lenis and the other consonant is a pre-aspirated stop. If we further specify the partial word-level ranking in (44) by ranking Dep(μ) above

[15] For reasons of space I will not consider candidates in which the cluster is repaired by other means, such as deletion or place assimilation.

(45)

	AGREE (C-pl)	HEAD MATCH (Σ)	DEP (μ)	DEP (S)	SON SEQ
a. 	*!				
b. 		*!		*	
☞ c. 				*	*
d. 			*!	*	

(46)



AGREE(C-pl), as in (46), then we obtain the observed result for the word-level input established in (31) for *corp* [kʰɔ́r̥p] 'body'. This is shown in the tableau in (47). Although the fully faithful candidate (a) violates AGREE(C-pl), any candidate in which epenthesis occurs (b) must necessarily violate higher-ranked DEP(μ) by inserting a mora.[16]

For the analysis of forms in which the sonorant is preceded by a long vowel or a

[16]It is not immediately obvious where the head occurs in a foot that does not branch at any level of metrical structure, i.e. a monomoraic foot. For our purposes here I assume that the head of a monomoraic foot is the syllable. This choice has no bearing on the outcome.

(47)

		Dep (μ)	Agree (C-pl)	Dep (*S*)
	kʰ ɔ r̥ p			
☞	a. kʰ ɔ r̥ p		*	
	b. kʰ ɔ r ɔ ʰp	*!		*

diphthong, I assume the following additional constraint taken from a constraint family proposed by Morén (1999):

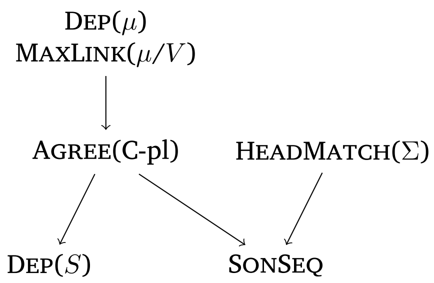
(48) MaxLink(μ/V): Let V_I be a vowel in the input and let V_O be its output correspondent. Assign a violation mark if V_O is linked to fewer morae than V_I.

I assume that Dep(μ) is once again responsible for the blocking of svarabhakti in forms of this type. If we add to the partial word-level ranking in (46) by ranking MaxLink(μ/V) above Agree(C-pl), as in (49), then we obtain the observed result for the word-level input established in (31) for ***Liùrbost*** [Lʲŭːrpɔst̪] 'Leurbost', as shown in the tableau in (50). Although the fully faithful candidate (a) again violates Agree(C-pl), any candidate in which epenthesis occurs must necessarily violate either higher-ranked Dep(μ) by inserting a mora (b), or higher-ranked MaxLink(μ/V) by shortening the vowel (c,d).[17]

4.5.3 /ə/-syncope and svarabhakti

In §4.3.3 I argued that /ə/-syncope in Scottish Gaelic is not a synchronically productive phonological process, but rather involves suppletive stem allomorphy. Therefore

[17] Note that the constraint *Lapse, defined in the next section, could also be responsible for the blocking of candidates (b) and (c) in (50). This is true only because the cluster is followed here by an unstressed syllable, but *Lapse would fail to block epenthesis in a hypothetical monosyllabic form */Lʲ$u_{\mu\mu}$rp/. I am aware of no monosyllabic items that exemplify the blocking of svarabhakti after a long vowel; however, it is unsafe to view this as anything more than an accidental gap, and therefore I will not rely on *Lapse to motivate the elimination of these candidates here.

(49) 

(50)

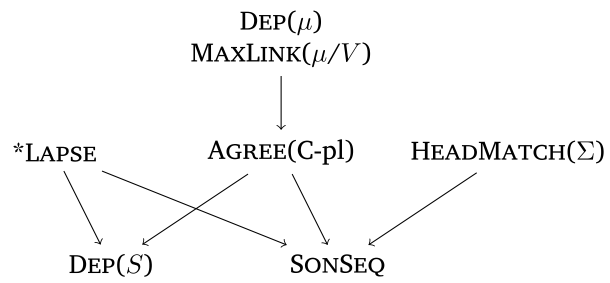
Lʲ uː r p ɔ s t̪	DEP (μ)	MAX LINK (μ/V)	AGREE (C-pl)	HEAD MATCH (Σ)	DEP (S)	SON SEQ
☞ a. Lʲ uː r p ɔ s t̪			*			
b. Lʲ uː r u p ɔ s t̪	*!				*	
c. Lʲ u r u p ɔ s t̪		*!		*	*	
d. Lʲ u r u p ɔ s t̪		*!			*	*

a form such as *fairchidh* [farʲáxʲ-i] 'feel-NPST' is derived from a monosyllabic stem allomorph /farʲxʲ/, rather than the disyllabic allomorph /farʲəxʲ/ found in unsuffixed forms. This part of the analysis will assume the following additional constraint, which is common in the phonological literature:

(51) *LAPSE: Let $\sigma_1\sigma_2$ be a sequence of two adjacent syllables in the output. Assign a violation mark if neither σ_1 nor σ_2 is stressed.

I assume that, in items with two listed stem allomorphs, both allomorphs are evalu-

(52)



ated in parallel in the phonology and *Lapse motivates the selection of the monosyllabic stem allomorph in suffixed forms. If we add to the partial word-level ranking in (49) by ranking *Lapse above both Dep(S) and SonSeq, as in (52), then we obtain the observed result for the two competing word-level inputs (a) and (b) for *fairchidh* [farʲáxʲ-i] 'feel-NPST', as shown in the tableau in (53). Candidate (i), which is fully faithful to input (a), violates high-ranked *Lapse. Meanwhile, candidate (ii), which is fully faithful to input (b), violates high-ranked Agree(C-pl) due to the presence of a heterorganic cluster, forcing epenthesis to occur in violation of low-ranked Dep(S). However, if the svarabhakti vowel were to project a syllable of its own (iii) then this would incur a violation of high-ranked *Lapse. The entire svarabhakti group therefore remains monosyllabic (iv) in violation of both Dep(S) and low-ranked SonSeq. An alternative repair (v), in which the svarabhakti vowel projects a syllable of its own but the first syllable remains dimoraic in order to satisfy HeadMatch(Σ) is blocked by high-ranked *Lapse and Dep(μ).

4.6 The realisation of the Class 1–Class 2 contrast

This part of the analysis explores the ways in which the C1–C2 contrast is realised in different dialects of Scottish Gaelic. Pitch and duration are discussed together in §4.6.1, and glottalisation in §4.6.2, showing how the various surface manifestations of the contrast correspond to the differing metrical structures established in §4.2.

4.6.1 Pitch and duration

The distinction between C1 and C2 forms is reflected in Lewis Gaelic primarily by means of tone (Borgstrøm 1940: 53–54, Oftedal 1956: 25–27, Ladefoged et al. 1998, Brown 2009, Nance 2015). C1 forms – in which the stressed syllable is monomoraic

(53)

Input	Candidate	DEP(μ)	*LAPSE	AGREE(C-pl)	HEADMATCH(Σ)	DEP(S)	SONSEQ
a. f a rʲ ə xʲ + i	i. f a rʲ ə xʲ i		*!				
b. f a rʲ xʲ + i	ii. f a rʲ xʲ i			*!			
	iii. f a rʲ a xʲ i		*!		*	*	
	☞ iv. f a rʲ a xʲ i					*	*
	v. f aː rʲ a xʲ i	*!	*			*	

– typically display a rising pitch on the first mora, while C2 forms – in which the stressed syllable is dimoraic – display a rising pitch spread across the first two morae; the pitch then falls sharply on any following syllable. As a result, a pitch peak occurs on the rightmost mora of the stressed syllable.[18] As well as in Lewis, this realisation of the C1–C2 contrast is also found in parts of Ross-shire (Borgstrøm 1941: 89, Wentworth 2005: 15–17). In accordance with recent analyses of tonal accent in Swedish (Morén-Duolljá 2013) and Franconian (Köhnlein 2011; 2016; 2018b; Hermans 2012; Kehrein 2018), this tonal contrast can be analysed as reflecting not lexical tone but rather the alignment of intonational tonal autosegments with differing metrical structures in the

[18] Monomoraic forms such as *corp* [kʰɔ́r̥p] 'body' display a rising pitch on their only mora and can thus be redundantly assigned to C1.

phrase-level phonology.

On the basis of the instrumental data presented by Ladefoged et al. (1998) for Bernera Gaelic, Ladefoged (2003: 275) suggests that, in isolated citation forms at least, the stressed syllable is assigned a LH tonal contour followed by a trailing L tone on any following unstressed syllable. Since the stressed syllable contains only the first mora in C1 forms and the first two morae in C2, this brings about the observed differences in the timing of the pitch peak, which is always aligned with the right edge of the stressed syllable. However, it is likely that a certain amount of variation exists according to dialect and phrasal context. Borgstrøm's (1940: 53–54) impressionistic description of Bernera Gaelic intonation very closely matches Ladefoged et al.'s (1998) instrumental results, but he specifies that the pitch rise on the stressed syllable is often "very reduced" in phrase-final position. This suggests the presence of a L% boundary tone which may suppress the H tone of the stressed syllable. Meanwhile, Oftedal's (1956: 26–27) description of Leurbost Gaelic notes that the stressed syllable may be either rising or high, suggesting that the first L tone may not always be realised. Interestingly, in an instrumental study on Ness Gaelic encompassing a variety of phrasal contexts, Brown (2009) finds that words in focus position display essentially the opposite tonal pattern to that assumed throughout this paper, with the right edge of the stressed syllable displaying a pitch trough followed by a sharp rise on the following syllable; meanwhile, no pitch differences are reported for non-focus, non-final contexts. In all of these cases, however, the accent contrast can be described in terms of the alignment of intonational tones with either monomoraic or dimoraic stressed syllables.

Unlike in Lewis, C1 and C2 forms are distinguished in Applecross, Ross-shire primarily by means of duration (Borgstrøm 1941: 128–129, Ternes 1973: 102–107). C1 forms display normal length, while C2 forms display overlength through elongation of the second mora, as shown in (1). However, Ternes (2006: ch. 5) reports a slight difference in pitch contour accompanying this durational distinction: C1 forms display a single early pitch peak followed by a sharp fall just as in Lewis, while C2 forms display a subtly double-peaked but overall more level pitch contour. Conversely, Brown (2009) reports differences in both duration and intensity accompanying the tonal contrast between C1 and C2 forms in Lewis Gaelic, and these differences remain even in non-focus, non-final contexts where no difference in pitch is reported. In Barra Gaelic, where the primary cue appears to be more difficult to pin down, Bosch & de Jong (1997) find differences in both pitch and duration between svarabhakti groups and ordinary ˈVCV sequences: svarabhakti groups display a later pitch peak – although not as late as in Lewis – and svarabhakti vowels are longer.

As discussed in detail by Köhnlein (2015), close relationships between pitch and duration are common cross-linguistically. For instance, in many Franconian dialects, the sharply falling pitch of Accent 1 is accompanied by considerably shorter duration than the more level Accent 2, and in certain phrasal contexts duration may even replace pitch as the primary cue to the contrast (Gussenhoven & Peters 2004; Peters 2006) – similar to Brown's (2009) findings for Ness Gaelic. The opposite pattern is found in Estonian, in which overlength is associated with falling pitch (Lehiste 1960). Interactions between pitch and duration are also known to occur in Swedish and Norwegian (Gårding 1973: 44), Serbo-Croatian (Lehiste & Ivić 1986: 59 ff.) and Livonian (Kiparsky 2018). Since it is clear that a trade-off between pitch and durational cues is often involved in the realisation of a single phonological opposition, there is no need to ascribe the Lewis and Applecross forms in (1) to different phonological surface representations. I therefore assume that Lewis and Applecross Gaelic differ only at the phonetic level with respect to the C1–C2 opposition. While Lewis Gaelic assigns greater weight to pitch in the phonetic interpretation of tone, Applecross Gaelic favours durational cues. Barra Gaelic can be taken to represent an intermediate dialect, in which pitch and duration are assigned more equal importance.

4.6.2 Glottalisation

While the dialects of the Outer Hebrides, Skye and Ross-shire distinguish C1 and C2 forms primarily by means of various combinations of pitch and duration, glottalisation may also play a small role in the realisation of the contrast. Throughout this region, Borgstrøm (1937: 74–77, 1940: 55–56, 152–153, 1941: 32, 89) reports the occurrence of a slight "break in tension" between the first and second morae of C1 forms, which in Barra may even be realised as a full "glottal catch" in hiatus sequences.

In many Argyll dialects, including those of Islay (Holmer 1938), Jura (Jones 2000; 2006; 2010) and Colonsay (Scouller 2017), the C1–C2 contrast is realised exclusively by means of glottalisation. C1 forms display a period of glottalisation between the first two morae while C2 forms do not, again as shown in (1). The distribution of glottalisation on vowels and sonorants in Argyll Gaelic exactly matches the distribution of the two tonal contours in Lewis. However, in order to determine the general distribution of glottalisation, it is necessary to take a closer look at its occurrence on obstruents. In Lewis Gaelic, a ˈVCV sequence containing an obstruent is always disyllabic and therefore bears the first-mora pitch peak of C1. According to *SGDS*, Jones (2000; 2006; 2010) and Scouller (2017), glottalisation occurs as expected in Argyll when the obstruent is a plain stop or a voiced fricative, but not when it is a pre-aspirated stop (realised as a voiceless fricative + stop cluster in this dialect) or a voiceless fricative:

(54) **Islay** (*SGDS*)

a. Pre-aspirated stop (→ fricative + stop)

litir	[Lʲihtʲər]	'letter'
socair	[soxkər]	'quiet'
tapaidh	[t̪ʰahpi]	'clever'

b. Plain stop

bradan	[praˀt̪an]	'salmon'
cogadh	[kʰoˀkəɣ]	'war'
leabaidh	[Lʲaˀpi]	'bed'

c. Voiceless fricative

drochaid	[t̪rɔxətʲ]	'bridge'
seasamh	[ʃesəv]	'stand.VN'
toiseachd	[t̪ʰoʃəxk]	'beginning'

d. Voiced fricative

fiodhan	[fi̯ɯˀɣan]	'cheese-press'
sabhal	[saˀvəL]	'byre'
sgamhan	[skeˀvan]	'lung'

I assume that pre-aspirated stops and voiceless fricatives in Scottish Gaelic bear the feature [+spread glottis] while other consonants do not. Given the foot structures proposed in §4.2.3, we can make the generalisation that glottalisation occurs whenever two syllables are parsed into a single foot, unless they are separated by a [+spread glottis] consonant. Glottalisation, which I assume to consist of epenthesis of [+constricted glottis], may represent a process of fortition that serves to enhance the boundary between two syllables that are in particularly close metrical contact, i.e. belong to a single foot (although this would run contrary to the cross-linguistic tendency for foot-medial consonants to be targets for lenition rather than fortition). Presumably, it is blocked by the presence of [+spread glottis] because these two features are articulatorily incompatible with one another.

Smith (1999), Hall (2003; 2006) and Iosad (2015) offer a different analysis of the distribution of glottalisation in Argyll Gaelic, regarding it as a segmental glottal stop inserted in the coda of a stressed monomoraic syllable in order to render it dimoraic and thus satisfy a stress-to-weight condition. Scouller (2017) reaches a similar conclusion, although he regards glottalisation as suprasegmental. The stress-to-weight analysis of glottalisation appears to be primarily motivated by Holmer's (1938: 36–37) claim that it occurs at the end of short open monosyllables, e.g. *teth* [tʲʰeˀ] 'hot', *math* [mɛˀ] 'good'. However, all other first-hand accounts disagree with Holmer on this vital point.[19] Glottalisation in this environment is not reported by Jones (2000; 2006; 2010) for Jura Gaelic and is not recorded in *SGDS* for any dialect. Scouller (2017) himself finds that it does not occur in this environment in Colonsay, but is forced by his own analysis to conclude that it must be "at least notionally present in such cases" (p. 261). Under the stress-to-weight approach, the absence of glottalisation in the forms in (54a) is taken to be because the voiceless fricatives are moraic codas, which is at odds with the present analysis. However, the forms in (54c) show that voiceless fricatives block glottalisation even when they are not codas, which none of these authors accounts for. Yet another problem for the stress-to-weight approach is that it requires that glottalisation serve as a moraic coda even when intervocalic, i.e. in hiatus forms such as *dubhan* [t̪uˀan] 'hook', *bodha* [poˀu] 'submerged rock', which would involve extremely unusual leftward syllabification of an intervocalic consonant.[20] I therefore conclude that glottalisation in Argyll Gaelic is best analysed as marking the boundary between two syllables that share a foot, unless they are separated by a [+spread glottis] consonant.

[19]The system described by Holmer (1938) differs from other accounts in a number of important ways. For instance, fortis sonorants are geminate not only in the coda but also intervocalically, and glottalisation does not affect obstruents.

[20]Recall from footnote 15 that I reject Borgstrøm's (1937; 1940; 1941) claim that VC.V syllabification is characteristic of C1 forms in Scottish Gaelic.

4.7 Discussion

In this section I offer some general discussion of the analysis presented in this paper. §4.7.1 outlines other analyses of the C1–C2 contrast in Scottish Gaelic and evaluates them against the present analysis. §4.7.2 places this analysis of Scottish Gaelic in its wider context by exploring how it relates to existing metrical analyses of tonal accent, glottalisation and overlength in languages such as Swedish, Danish, Franconian and Estonian.

4.7.1 Other analyses

The claim that the C1–C2 contrast in Scottish Gaelic reflects metrical structure has been put forward by numerous authors in the past. However, analyses disagree on the exact nature of the metrical structures involved and the manner in which they are derived, particularly with regard to svarabhakti groups. Some authors tackle the problem by viewing svarabhakti vowels as entirely non-phonological. Iosad (2015) analyses svarabhakti as a purely phonetic process, so that svarabhakti vowels are invisible to the surface phonology and are therefore unable to project a syllable of their own. Within the framework of Articulatory Phonology, Hind (1996; 1997) and Hall (2003; 2006) ascribe svarabhakti to the relative realignment of overlapping articulatory gestures, which causes a consonantal gesture to occur in the middle of a single long vocalic gesture. However, these approaches have difficulty dealing with the various cases of opacity in svarabhakti, such as the apparent overapplication before hiatus in (13) and the underapplication in sonorant + [h] clusters in (14) or before Barra Gaelic [xk] in (36). Hall's (2003) analysis is equipped with a means to account for lexically specific overapplication of svarabhakti, but she does not consider these cases of underapplication. Clearly, any successful account of svarabhakti must be capable of handling its complex interactions with other phonological processes.

Some authors propose complex multi-layered structures to represent the contrast between C1 and C2 forms. On the basis of phonetic data from Barra Gaelic, Bosch & de Jong (1998) argue that each of the two vowels in a svarabhakti group heads a syllable within a larger domain which they term a "super-syllable". The existence of the lower "syllable" level – at which the two vowels in a svarabhakti group belong to separate domains – is based on an observed asymmetry between the two vowels with respect to both stress and backness. Specifically, svarabhakti vowels in Barra Gaelic display greater stress than the preceding vowel according to phonetic criteria such as pitch and duration, and receive their backness specification from the intervening consonant rather than from the preceding vowel. However, it is not clear why the phonetic correlates of stress should be expected to remain constant throughout the duration of a stressed syllable, nor is there any reason why two vowels in a single syllable should necessarily agree in backness. There is therefore very little motivation for positing an entirely new level of prosodic representation, instead of simply equating the higher-level domain – which contains both vowels in a svarabhakti group – with a traditional syllable.

Smith (1999) argues that a svarabhakti vowel heads a syllable that is recursively embedded within a larger syllable headed by the preceding vowel. The embedded syllable is posited for theory-internal reasons and Smith does not justify its existence using data from Scottish Gaelic. Although this representation can account for the monosyllabic nature of svarabhakti groups, the derivational part of Smith's analysis relies on a family of constraints whose precise definitions are unclear. For instance, the constraint SONCSEP is stated as follows:

(55) SONCSEP: A cluster of a sonorant consonant and any non-syllabic must be separated by an epenthetic vowel, i.e. must form a recursive syllable with an explicit nucleus. One of the two elements in the cluster must be non-coronal. (Smith 1999: 613)

Contrary to the core principles of Optimality Theory, this constraint simultaneously states not only the output structure that it disfavours (a particular type of cluster) but also the repair that is to be carried out in order to satisfy it (insertion of an epenthetic vowel in a recursively embedded syllable). If we attempt to convert this into a standardly formulated markedness constraint targeting clusters of the appropriate type, we are left with no motivation for placing the epenthetic vowel in a recursively embedded syllable rather than an ordinary non-embedded one. Smith's analysis therefore brings us no closer to understanding how the special prosodic properties of svarabhakti groups might be derived.

Not all analyses of the C1–C2 contrast in Scottish Gaelic involve metrical structure. Ternes (1980; 2006: ch. 5) argues that Scottish Gaelic has lexical tone and draws a comparison with other northern European languages, such as Swedish and Norwegian, for which tonal analyses were predominant at the time. However, this approach does not account for the many ways, discussed in §4.2.2 and §4.3.1, in which the C1–C2 contrast interacts with segmental structure. A very different non-metrical analysis is offered by Stanton & Zukoff (2018), who regard the special prosodic properties of svarabhakti groups as reflecting the fact that both vowels are stressed. The presence of stress on both vowels in a svarabhakti group is of course consistent with the present analysis, and forms part of many impressionistic descriptions of the C1–C2 contrast for various Scottish Gaelic dialects (Fraser 1914; Borgstrøm 1937; 1940; 1941; Oftedal 1956; Dilworth 1972; Wentworth 2005). However, rather than regarding both vowels as belonging to a single stressed syllable, Stanton & Zukoff ascribe this stress pattern to correspondence constraints that motivate identity between epenthetic vowels and their hosts with respect to prosodic properties. As discussed by Morrison (2018a), this analysis is problematic because it considers svarabhakti in isolation rather than in the wider context of the C1–C2 contrast, and some aspects of the analysis rely on incorrect assumptions about the distribution of vowel length in Scottish Gaelic.

4.7.2 Wider context

In ascribing the the C1–C2 contrast in Scottish Gaelic to differences in metrical structure, the analysis presented in this paper bears a degree of similarity to analyses proposed for contrasts of tone, glottalisation and overlength in other languages. Morén-Duolljá (2013) argues that Swedish words with Accent 2 contain a recursive foot while those with Accent 1 do not, and the tonal accent opposition results from the alignment of intonational tones with these differing metrical structures. Meanwhile, Iosad (2016) analyses Danish stød as reflecting recursive foot structure in a similar manner. As for Franconian, Hermans (2012) and Kehrein (2018) analyse Accent 1 words as containing a monosyllabic foot and Accent 2 words a disyllabic foot, whereas Köhnlein (2011; 2016; 2018a;b) proposes the opposite. Finally, Prince (1980) and Odden (1997) argue that long syllables in Estonian belong to a disyllabic foot while overlong syllables consititute a foot on their own. Although the exact nature of the relevant contrast varies from one account to another, what unites the present analysis with most of the aforementioned analyses is that the surface contrast is mediated through faithfulness to foot structure.

While most of these analyses derive the relevant surface contrasts through faithfulness to metrical structure that is lexically stored, the present analysis shows, using the framework of Stratal OT, that the surface contrast between C1 and C2 forms in Scottish Gaelic is predictable on the basis of their underlying segmental content. In this respect, this account bears a striking similarity to van Oostendorp's (2018) analysis of tonal accent on pre-obstruent short vowels in Moresnet Franconian. According to his analysis, metrical structure is built at the stem level and is sensitive to the voicing specification of the obstruent, but may subsequently be rendered opaque by final devoicing or voice assimilation at the word level. In diachronic terms, when viewed in the light of the life cycle of phonological processes (Bermúdez-Otero 2007; 2011: §3; 2015; Bermúdez-Otero & Trousdale 2012: §2), it can be assumed that languages displaying contrastive metrical structure must at one time have gone through a similar stage, where metrical structure ceased to be completely surface-true and began interacting opaquely with phonological or morphological processes before eventually undergoing lexicalisation. Scottish Gaelic can therefore be regarded as a missing link in the evolution of lexically contrastive metrical structure.

By highlighting the connection between tonal accent, glottalisation and overlength in different dialects of Scottish Gaelic, the present analysis hopes to help consolidate the relationship between these three phenomena in other languages in which they occur. As discussed in §4.6.1, the link between tone and duration is well-known. Köhnlein (2015) proposes a recurring diachronic pathway in which phonetically longer units first come to bear more complex tonal contours. A tendency to lengthen units with level tones then results in a durational reversal, so that the originally shorter unit becomes the longer one. A language in which longer duration is associated with a contour tone, e.g. Estonian, can be assumed to lie at an early stage of this pathway, while one in which longer duration is associated with a more level tone, e.g. Franconian, represents a later stage. Applying this to Scottish Gaelic, it appears that Applecross represents a particularly progressive dialect in which the relatively level tone of C2 forms has been replaced by longer duration. As for the link between tone and glottalisation, it is known that the sharp pitch fall inherent in a HL tonal contour is liable to result in creaky voice (e.g. Lindblom 2009; Riad 2009). The cognate relationship between the typically early-peaked Accent 1 of Swedish and stød in Danish is clearly paralleled by the C1–C2 contrast in Scottish Gaelic, where C1 is characterised by both an early pitch peak in Lewis and glottalisation in Argyll. Finally, the various realisations of the C1–C2 contrast in Scottish Gaelic are perfectly matched in Livonian, in which one of two phonological classes is distinguished from the other by means of a simultaneous combination of falling pitch, glottalisation and shorter duration (Kiparsky 2018).

4.8 Conclusion

This paper has used the framework of Stratal OT to build a complete and thorough analysis of the C1–C2 contrast in Scottish Gaelic, which is realised by means of tonal accent, glottalisation or overlength depending on dialect. In line with a number of recent analyses of similar phonological oppositions in other languages of Europe, this contrast was ascribed to differences in metrical structure. It was shown that metrical structure in Scottish Gaelic is built in the phonology in a regular manner, but may be rendered opaque by complex interactions with other phonological processes. This results in the observed surface contrast between C1 and C2 forms. In §4.7 it was argued that this analysis outperforms others at explaining the extremely complex facts of Scottish Gaelic phonology. It was also argued that Scottish Gaelic can be thought of as representing an intermediate stage in the diachronic trajectory that led to the lexically contrastive metrical structure observed in other languages today, and can inform us about the relationship between the oppositions of tone, glottalisation and overlength found in those languages. The contrast between C1 and C2 forms in Scottish Gaelic is just one of the myriad ways in which the intricacies of the Scottish Gaelic sound system can enhance our understanding of the kinds of phonological phenomena that occur in the languages of the world.

Chapter 5

The broad–slender contrast: A Stratal OT analysis

5.1 Introduction

Scottish Gaelic displays an important opposition between *broad* (non-palatalised) and *slender* (palatalised) series of consonants at the coronal and dorsal places of articulation, while labial consonants and [h] – which are neither overtly broad nor slender – may be termed *neutral*. A parallel opposition holds among the vowels, which are similarly either *broad* (non-front) or *slender* (front). Although this opposition, which I refer to here as *slenderness*, is generally held to be fully contrastive on both consonants and vowels, closer inspection of the phonotactics of Scottish Gaelic reveals a deep interaction between the quality of vowels and the quality of adjacent consonants. Specifically, while rounded vowels are exclusively broad, unrounded vowels nearly always agree in slenderness with a preceding coronal or dorsal consonant, although the following consonant may also play a role. As a result, the contrast between front and back unrounded vowels that is universally described in phonological overviews of Scottish Gaelic (e.g. Clement 1984; MacAulay 1992b; Ternes 1994; Lamb 2003; Gillies 2009; Bosch 2010a) is in fact highly marginal in this environment.

In this paper I show that the broad–slender contrast underlyingly extends to neutral consonants as well as to apparently empty onsets, which I argue contain an underspecified consonant. This means that an unrounded vowel may be said to take its slenderness from the preceding consonant even in cases where the preceding consonant is neither overtly broad nor slender. Using data from a detailed descriptive study of the dialect of Leurbost in Lewis by Oftedal (1956), I conclude that the slenderness of an unrounded vowel is therefore predictable from its underlying consonantal environment in the vast majority of words, with only a small number of lexically marked exceptions. Since rounded vowels, for their part, are inevitably broad, it follows that slenderness need rarely be specified on vowels in underlying representations. This predictability is masked on the surface by complex opaque interactions between slenderness agreement and other processes, such as initial mutations that may change the slenderness of an initial consonant, or the neutralisation of underlying slenderness in neutral consonants. This opacity is accounted for using the framework of Stratal OT outlined in ch. 1, §1.1. Using this framework, the extremely complex interactions that exist between slenderness agreement and other phonological or morphological processes in Scottish Gaelic can be accounted for in a principled manner.

This paper offers an unprecedentedly thorough treatment of an important yet much-neglected area of Scottish Gaelic phonology, *viz.* the degree of interdependency that exists between consonants and vowels with respect to the broad–slender contrast and the synchronic derivation of the observed patterns. It serves to demonstrate the power of Stratal OT in extracting order from highly complex data, as well as the utility of representational tools such as covert phonological structure in the analysis of morphophonological phenomena.

The structure of the paper is as follows. §5.2 introduces the broad–slender contrast in Scottish Gaelic, as well as the *initial mutations* and mutation-like phenomena whose interactions with the broad–slender contrast will play a pivotal role in the analysis. §5.3 shows that the slenderness of a stressed vowel is transparently predictable in over 91% of those word-forms in which the preceding consonant is overtly broad or slender. Next, §5.4 shows how the underlying slenderness of a consonant may differ from its overt slenderness on the surface, and that *all* stressed vowels are preceded by either a broad or slender consonant in underlying forms, meaning that the slenderness of a stressed vowel can be regarded as phonologically derived in over 94% of all word-forms. §5.5 then provides a constraint-based analysis showing how the observed surface forms are derived from the proposed underlying forms via several consecutive rounds of phonological processing. Finally, §5.6 provides some general discussion and

§5.7 concludes the paper.

5.2 Background

In this section I provide background information on the broad–slender contrast in Scottish Gaelic, as well as the *initial mutations* and mutation-like processes with which it may interact. §5.2.1 discusses the broad–slender opposition in consonants and vowels in Scottish Gaelic. Since the broad–slender opposition is not found in unstressed vowels, and stress nearly always occurs on the initial syllable, the main focus throughout this paper will be on initial consonants or clusters and the immediately-following vowel. §5.2.2 then introduces the *initial mutations* of Scottish Gaelic, while §5.2.3 introduces a set of mutation-like phenomena which I refer to as *prothetic* consonants. Both initial mutation and prothesis involve alternations in initial consonants that shed light upon the phonology of the broad–slender contrast. Finally, §5.2.4 provides details of the data set upon which the analysis is based, which is a corpus of over 3,000 unique word-forms explicity cited in Oftedal (1956).

5.2.1 Slenderness

The consonant inventory reported by Oftedal (1956) for Leurbost, Lewis, is as described in ch. 1, §1.2.1, except for the inclusion of two further consonants /θ w/ that are occasionally found in English or Scots loans. Recall that coronal and dorsal consonants are divided into *broad* (non-palatalised) and *slender* (palatalised) series, while labial consonants and /h/ are neither overtly broad nor slender.[1] A very common morphophonological process known as *slenderisation* replaces stem-final broad coronal and dorsal consonants with their slender counterparts. For example, slenderisation occurs in the paradigms of Type I and Type II nouns, which display a broad stem-final consonant in the direct[2] case and its slender counterpart in the genitive case:[3]

(1)	**Broad** (DIR)		**Slender** (GEN)		
	slat	[sLa^{h}t̪]	*slait*	[sLɛ^{h}t^{j}]	‘rod’

[1] For the purposes of the token counts later in this paper, I count [θ w] in English or Scots loans as broad consonants.

[2] Traditionally “nominative”.

[3] In conservative Scottish Gaelic, Type II nouns mark genitive case with final [-ə] in addition to slenderisation, e.g. *slaite* [sLɛ^{h}t^{j}-ə] ‘rod-GEN’. Oftedal generally records these forms without [-ə].

snàthad	[sNaːhət̪]	*snàthaid*	[sNaːhit^{j}]	‘needle’
sloc	[sLɔ^{h}k]	*sluic*	[sLu^{h}k^{j}]	‘pit’
caileag	[k^{h}al^{j}ak]	*caileig*	[k^{h}al^{j}ak^{j}]	‘girl’
solas	[sɔLəs]	*solais*	[sɔLiʃ]	‘light’
fraoch	[frɯːx]	*fraoich*	[frɯːx^{j}]	‘heather’
gràdh	[kraːɣ]	*gràidh*	[kraːj]	‘love’
cracann	[k^{h}ra^{h}kəN]	*cracainn*	[k^{h}ra^{h}kiN^{j}]	‘skin’
amhran	[auran]	*amhrain*	[auraN^{j}]	‘song’
peirceall	[p^{h}er̥^{j}k^{j}əL]	*peircill*	[p^{h}er̥^{j}k^{j}iL^{j}]	‘jaw’
diabhal	[t^{j}iəvəL]	*diabhail*	[t^{j}iəvəl^{j}]	‘devil’
òr	[ɔːr]	*òir*	[ɔːr^{j}]	‘gold’

These alternations, shown in full in Table 5.1, demonstrate the systematic pairings that exist between broad and slender consonants. In particular, they shed light upon the complex phonological relationships that exist among the coronal sonorants, where several asymmetries occur in the surface inventory – note the absence of slender lenis */n^{j}/, broad lenis */l/ and slender fortis */R^{j}/ in Table 1.1. First of all, slender fortis [N^{j}] functions as the slender counterpart to both broad fortis [N] and broad lenis [n]. I therefore assume that a word-level ban on slender lenis *[n^{j}] drives a fortition process whenever broad lenis /n/ undergoes slenderisation, resulting in slender fortis [N^{j}]. Secondly, both slender fortis [L^{j}] and slender lenis [l^{j}] function as slender counterparts to broad fortis [L] on a lexically-specific basis. I therefore assume that [L] actually represents an underlying broad lenis /l/ in those cases where it alternates with slender lenis [l^{j}], and that a word-level ban on this segment drives another fortition process whenever it is not “rescued” by slenderisation. This is confirmed by the fact that in forms where broad fortis [L] alternates with slender lenis [l^{j}], e.g. *geal* [k^{j}aL] ‘white’, CMP *gile* [k^{j}il^{j}ə], the stem-final lateral of the non-slenderised form fails to trigger *lengthening* of a preceding tautosyllabic stressed short vowel despite being fortis on the surface – *see* ch. 4, §4.4 for an analysis in which lengthening occurs only if the triggering sonorant is already fortis in the stem-level output. Finally, [R] and the velarised retroflex consonants (representing underlying /R/ + coronal) have no slender counterparts and are unaffected by slenderisation.

Table 5.1: Slenderisation alternations among stem-final coronal and dorsal consonants

Broad	ʰt̪	t̪	ʰk	k	s	x	ɣ	N	n	L /L/	L /l/	r
Slender	ʰtʲ	tʲ	ʰkʲ	kʲ	ʃ	xʲ	j	Nʲ	Nʲ	Lʲ	lʲ	rʲ

If the stem ends in a cluster, then slenderisation affects both consonants, e.g. *trosg* [t̪ʰrɔsk] 'cod', genitive *truisg* [t̪ʰruʃkʲ]. However, the stem-final cluster [-xk] is exceptional in that it never alternates. Stem-final [-əɣ] alternates with [-i] under slenderisation, e.g. *geamhradh* [kʲaurəɣ] 'winter', genitive *geamhraidh* [kʲauri] – I therefore assume that unstressed [i] represents underlying /əj/ when it occurs word-finally or before hiatus.

In terms of representation, I assume that broad and slender consonants bear V-place features [−front] and [+front] respectively, and that slenderisation represents the addition of a suffix consisting of a [+front] autosegment that docks to the final consonant(s) of the stem. Note that slenderisation in monosyllabic stems is often accompanied by phonologically unpredictable alternations in the quality of the vowel, most commonly [ɛ∼i], [ɔ∼u], [a∼u], [iə∼eː] and [ia∼(ɛ̯)ɔː], which I refer to as *ablaut* – without entering into further detail it can be assumed that certain stems, on a phonologically arbitrary basis, select for an allomorph of this slenderisation suffix that contains additional featural material.

A number of clusters occur in word-initial position in Lewis Gaelic. These can be divided into *non-*s*-clusters* and s*-clusters*, shown in Tables 5.2 and 5.3 respectively. Those clusters shown in parentheses are known to occur in Scottish Gaelic in general, but happen not to be found in Oftedal's data. Non-*s*-clusters can be characterised as consisting of combinations of non-sibilant obstruent + lenis liquid, if fortis [L] here is assumed to represent underlying lenis /l/. *S*-clusters, on the other hand, are combinations of either sibilant + unaspirated stop (+ lenis liquid), or sibilant + fortis sonorant. The gaps *[t̪ʰrʲ t̪rʲ st̪rʲ hrʲ] can be ascribed to a general ban on [rʲ] after a coronal stop, coupled with the fact that initial [h] usually only occurs as a result of mutation of underlying /t̪ʰ/ or /s/ (*see* §5.2.2) – note that the absence of these clusters means that the broad clusters [t̪ʰr t̪r st̪r hr] have no slender counterparts. The two remaining gaps *[st̪L st̪lʲ] could be regarded as accidental, given the overall symmetry of the system, despite not being known to occur in Scottish Gaelic at all – such gaps would be statis-

Table 5.2: Word-initial non-*s*-clusters in Scottish Gaelic

	Labial		**Coronal**		**Dorsal**		**Glottal**	
	Broad	**Slender**	**Broad**	**Slender**	**Broad**	**Slender**	**Broad**	**Slender**
Stop + ***l***	pʰL pL	pʰlʲ plʲ	t̪ʰL t̪L	t̪ʰlʲ (t̪lʲ)	kʰL kL	kʰlʲ klʲ	n/a	n/a
Stop + ***r***	pʰr pr	pʰrʲ prʲ	t̪ʰr t̪r		kʰr kr	kʰrʲ krʲ	n/a	n/a
Fric. + ***l***	fL vL	flʲ vlʲ	n/a	n/a	xL ɣL	xlʲ ɣlʲ	(hL)	(hlʲ)
Fric. + ***r***	fr vr	frʲ vrʲ	n/a	n/a	xr ɣr	xrʲ ɣrʲ	hr	

Table 5.3: Word-initial *s*-clusters in Scottish Gaelic

	Labial		**Coronal**		**Dorsal**	
	Broad	**Slender**	**Broad**	**Slender**	**Broad**	**Slender**
s **+ stop**	sp		st̪	ʃtʲ	sk	skʲ
s **+ stop +** ***l***	(spL)	(splʲ)			(skL)	sklʲ
s **+ stop +** ***r***	(spr)	sprʲ	st̪r		(skr)	skrʲ
s **+ nasal**	sm		sN	ʃNʲ	n/a	n/a
s **+ lateral**	n/a		sL	ʃLʲ	n/a	n/a

tically unsurprising, since clusters of coronal stop + lateral are themselves very rare. Note that only the last component of a word-initial cluster may be slender, while all preceding components are broad or neutral, with the exception that a sibilant agrees in slenderness with an immediately-following coronal. An entire word-initial cluster can therefore be referred to as either broad, slender or neutral on the basis of its last component, while the slenderness of all preceding components is fully predictable.

The stressed monophthongal vowel inventory reported by Oftedal (1956) for Leurbost is as described in ch. 1, §1.2.2. Unrounded vowels may be either *broad* (non-front) or *slender* (front), parallel to the broad–slender opposition found among the consonants, while all rounded vowels can be regarded as *broad*. I assume that broad and slender vowels bear V-place features [−front] and [+front] respectively, and that unrounded and rounded vowels are [−round] and [+round]. I also assume that that close vowels are [+high,−low], close-mid vowels (henceforth referred to as *mid* vowels in this paper) are [−high,−low] and open-mid or open vowels (henceforth both *open* vowels) are [−high,+low].

The inventory of unstressed vowels is also largely as described in §1.2.2, except that Oftedal (1956) cites a handful of forms containing unstressed vowel qualities that cannot be straightforwardly accounted for by contextual colouring of underlying /ə/. Setting aside these anomalous forms, the underlying inventory of unstressed vowels can most likely be represented as a three-way contrast between [−low,−round] /ə/, [+low,−round] /a/ and [+low,+round] /ɔ/ – since the broad–slender opposition plays no role here, no further attention will be paid to unstressed vowels in this paper.

5.2.2 Initial mutation

As in all of the Insular Celtic languages, stem-initial consonants in Scottish Gaelic are subject to morphosyntactically-triggered alternations known as *initial mutations*, generally involving the substitution of one consonant for another. There exists an extensive literature on the Celtic initial mutations and their correct place in the grammar (e.g. Hamp 1951; Oftedal 1962; Ellis 1965; Rogers 1972; Ó Dochartaigh 1978; Ewen 1982; Lieber 1983; 1987; Ball & Müller 1992; Kibre 1997; Pyatt 1997; Stewart 2004; Green 2006; Wolf 2007; Hannahs 2013; Iosad 2014; 2017). While initial mutations very often occur in the presence of an immediately-preceding overt trigger word, they may also represent an inherent part of the exponence of certain morphological categories in Scottish Gaelic, e.g. genitive plural in nouns, genitive in proper nouns and agreement for various case–number–gender combinations in attributive adjectives. They must therefore be regarded as a type of morphology, analogous to inflectional operations such as case marking, rather than as some form of phrase-level phonological sandhi. By far the most important initial mutation in Scottish Gaelic is *lenition*, which involves alternations between *radical* (unmutated) consonants and their *lenited* counterparts:

(2)

Radical			**Lenited**		
pòsadh	[pʰɔːsəɣ]	‘marry.VN’	*phòs*	[fɔːs]	(PST)
baile	[palʲə]	‘town’	*bhaile*	[valʲə]	
tuig	[t̪ʰɯkʲ]	‘understand’	*thuig*	[hɯkʲ]	(PST)
duine	[t̪ɯNʲə]	‘man’	*dhuine*	[ɣɯNʲə]	
tilleadh	[tʲʰiLʲəɣ]	‘return.VN’	*thilleadh*	[hiLʲəɣ]	
deise	[tʲeʃə]	‘suit’	*dheise*	[jeʃə]	
cat	[kʰaʰt̪]	‘cat’	*chat*	[xaʰt̪]	
gorm	[kɔrɔm]	‘blue’	*ghorm*	[ɣɔrɔm]	
ceann	[kʲʰauN]	‘head’	*cheann*	[xʲauN]	
geamhradh	[kʲaurəɣ]	‘winter’	*gheamhradh*	[jaurəɣ]	
fàg	[faːk]	‘leave’	*fhàg*	[aːk]	

Table 5.4: Lenition of initial consonants

Radical	p^{h}	p	t̪^{h}	t̪	t^{jh}	t^{j}	k^{h}	k	k^{jh}	k^{j}	f	s	ʃ	m	N	N^{j}	L^{j}	R
Lenited	f	v	h	ɣ	h	j	x	ɣ	x^{j}	j	Ø	h	h	v	n	n	l^{j}	r

sadadh	[sat̪əɣ]	'throw.VN'	*shad*	[hat̪]	(PST)
seasamh	[ʃɛsu]	'stand.VN'	*sheasamh*	[hɛsu]	
mullach	[muLəx]	'roof'	*mhullach*	[vuLəx]	
nàbaidh	[Na:pi]	'neighbour'	*nàbaidh*	[na:pi]	
nighean	[N^{j}i.un]	'girl'	*nighean*	[ni.un]	
leabaidh	[L^{j}api]	'bed'	*leabaidh*	[l^{j}api]	
ràmh	[Ra:v]	'oar'	*ràmh*	[ra:v]	

The full set of alternations in single consonants is shown in Table 5.4. Lenition mostly involves frication and/or debuccalisation of obstruents and /m/, and the replacement of fortis coronal sonorants with their lenis counterparts. Note that initial broad fortis /L/ does not alternate under lenition, since it has no lenis counterpart. On the other hand, although slender fortis /N^{j}/ likewise has no lenis counterpart, lenition is achieved in this case by means of concomitant broadening to broad lenis [n]. Note also that slender lenis [r^{j}] does not occur as the outcome of lenition, since it has no fortis counterpart.[4]

Only those consonants that appear in the "Radical" row, along with /L/, occur in initial position in native lexical roots. Meanwhile, those that appear exclusively in the "Lenited" row normally occur in initial position only as a result of lenition. This is not a general phonotactic restriction, however, since these consonants, along with /r^{j}/, are occasionally found in initial position in non-alternating closed-class items such as prepositions (e.g. *le* [l^{j}ɛ] 'with', *ri* [r^{j}i] 'by'), pre-verbal particles (e.g. *cha* [xa], *nach* [nax]) and some irregular verb forms (e.g. *bheir* [ver^{j}] 'give.NPST.INDEP', *gheibh* [jo] 'get.NPST.INDEP'). Some may also occur in initial position in loanwords and placenames.

Lenition of non-*s*-clusters simply entails lenition of the first component, e.g. *grian* [kr^{j}iən] 'sun', lenited *ghrian* [ɣr^{j}iən]. On the other hand, lenition of /sN ʃN^{j} sL ʃL^{j} st̪r/

[4]Since radical initial /f/ is deleted under lenition, initial [r^{j}] would be expected to occur as the result of lenition of /fr^{j}/. However, Oftedal (1956) claims that the outcome of lenition of /fr^{j}/ is in fact broad [r], citing the single example *frithealadh* [fr^{j}ihal^{j}əɣ] 'serve', past *fhritheal* [rihal^{j}].

Table 5.5: Lenition of initial *s*-clusters

Radical	sN	ʃNʲ	sL	ʃLʲ	st̪r /sR/
Lenited	n	n	L	lʲ	r

is more complex:

(3)

Radical			**Lenited**	
snàthad	[sNaːhət̪]	‘needle’	*shnàthad*	[naːhət̪]
sneachd	[ʃNʲɛxk]	‘snow’	*shneachd*	[nɛxk]
slat	[sLaʰt̪]	‘rod’	*shlat*	[Laʰt̪]
sleamhainn	[ʃLʲɛviNʲ]	‘slippery’	*shleamhainn*	[lʲɛviNʲ]
sreang	[st̪rɤiɣ]	‘string’	*shreang*	[rɤiɣ]

The full set of alternations is shown in Table 5.5. On the basis of the overall symmetry of the system, I assume that initial [st̪r] represents underlying /sR/. These clusters therefore all consist of /s∼ʃ/ + a fortis coronal sonorant, and lenition is realised through both deletion of /s∼ʃ/ and lenition of the sonorant. The remaining *s*-clusters do not alternate under lenition. There are probably also some items in which initial [st̪r] represents “true” underlying /st̪r/ and therefore does not alternate (*see* e.g. Bauer 2011: 358–359), although Oftedal does not note this.

The only other alternation that I regard as a true initial mutation in Scottish Gaelic is a phenomenon that I refer to as t-*substitution*. This can be regarded as a special subtype of lenition that targets initial /s∼ʃ/ after certain forms of the definite article:

(4)

Radical			***T*-substituted**		
saighdear	[sɤitʲarʲ]	‘soldier’	*an t-saighdear*	[ə Nᵈ̪ʱɤitʲarʲ]	‘the S.PREP’
seachdain	[ʃɛxkɔNʲ]	‘week’	*an t-seachdain*	[ə NᵈʲʱɛxkɔNʲ]	‘the week’
snàthad	[sNaːhət̪]	‘needle’	*an t-snàthad*	[ə Nᵈ̪ʱraːhət̪]	‘the needle’
sneachd	[ʃNʲɛxk]	‘snow’	*an t-sneachd*	[ə Nᵈ̪ʱrɛxk]	‘the snow.PREP’
slat	[sLaʰt̪]	‘rod’	*an t-slat*	[ə Nᵈ̪ʱLaʰt̪]	‘the rod’
slighe	[ʃLʲi.ə]	‘way’	*an t-slighe*	[ə Nᵈ̪ʱlʲi.ə]	‘the way’
sreang	[st̪rɤiɣ]	‘string’	*an t-sreang*	[ə Nᵈ̪ʱrɤiɣ]	‘the string’

The forms of the definite article that trigger *t*-substitution also trigger *n*-prothesis at the phrase level (*see next section*). Abstracting away from the subsequent effects of *n*-

Table 5.6: *T*-substitution of initial /s∼ʃ/

Radical	s	ʃ	sN	ʃNʲ	sL	ʃLʲ	st̪r /sR/
***T*-substituted**	t̪ʰ	tʲʰ	t̪ʰr	t̪ʰr	t̪ʰL	t̪ʰlʲ	t̪ʰr

prothesis on the outcome of *t*-substitution, the full set of alternations is shown in Table 5.6. The changes that occur are identical to lenition except that /s∼ʃ/ is replaced by [t̪ʰ∼tʲʰ] rather than undergoing debuccalisation or deletion, along with a phonotactic repair *[t̪ʰn] → [t̪ʰr]. The remaining *s*-clusters do not alternate under *t*-substitution (as with lenition, there are probably also some items that begin with "true" underlying /st̪r/ and therefore do not alternate).

Following authors such as Lieber (1983; 1987), Wolf (2007) and Iosad (2014; 2017), I adopt a concatenative approach to initial mutation in which it represents the addition of a prefix consisting of an autosegmental feature bundle that docks to the initial consonant of the stem. Although many details remain to be worked out, I will assume for the purposes of this paper that a given stem-initial consonant selects for an allomorph of this mutation prefix containing whatever featural material is necessary to bring about the observed substitution.

5.2.3 Prothetic consonants

A number of function words in Scottish Gaelic trigger the insertion of a *prothetic* consonant at the beginning of the immediately-following word under certain circumstances, most often when the latter begins with a vowel. Prothesis differs from initial mutation in that it can be analysed as the straightforward insertion of a consonant rather than the subsitution of one consonant for another, and usually may only occur in the presence of an immediately-preceding overt trigger word.[5] Prothesis may also be observed acting upon the output of initial mutation.

Most prothetic consonants come in both a broad and a slender form. Roughly speaking, the broad form occurs before an initial broad vowel and the slender form before an initial slender vowel, although the exact rule will be discussed in §§5.4.4–5.4.5:

[5]The only exception is *dh*-prothesis in independent past tense and conditional verb forms, which has no overt trigger. I assume that the prothetic consonant here is the sole realisation of an otherwise phonologically null pre-verbal particle: this particle can be directly observed in its overt allomorph *do* [t̪ə] in dependent past tense verb forms.

(5)	**Radical**			**With prothetic C**		
a. *N*-prothesis:						
	ad	[at̪]	'hat'	*an ad*	[ə N$^{d̪}$at̪]	'the hat'
	each	[ɛx]	'horse'	*an each*	[ə N^{dj}ɛx]	'the h.PREP'
b. *Nt*-prothesis:						
	ainm	[anam]	'name'	*an t-ainm*	[ə N$^{d̪ɦ}$anam]	'the name'
	iasg	[iəsk]	'fish'	*an t-iasg*	[ə N^{djɦ}iəsk]	'the fish'
c. *H*-prothesis:						
	athair	[ahər^{j}]	'father'	*a h-athair*	[ə hahər^{j}]	'her father'
	eileanan	[el^{j}anən]	'island.PL'	*na h-eileanan*	[nə hel^{j}anən]	'the island.PL'
d. *Dh*-prothesis:						
	airgead	[ar^{j}ak^{j}ət̪]	'money'	*a dh'airgead*	[ə ɣar^{j}ak^{j}ət̪]	'of money'
	ith	[ix^{j}]	'eat'	*dh'ith*	[jix^{j}]	'eat.PST'
e. *G*-prothesis:						
	obair	[opər^{j}]	'work.VN'	*ag obair*	[ə kopər^{j}]	'working'
	iarraidh	[iəRi]	'want.VN'	*ag iarraidh*	[ə k^{j}iəRi]	'wanting'

The full set of prothetic consonants that occur in the variety described by Oftedal is shown in Table 5.7. These are inserted in the initial onset of vowel-initial words (including those that are vowel-initial as a result of the deletion of radical /f/ under lenition). Note that the post-stopped nasals that occur as a result of ***n***-prothesis and ***nt***-prothesis imply underlying clusters /Nt̪∼N^{j}t^{j}/ and /Nt̪^{h}∼N^{j}t^{jh}/ respectively (*see* ch. 1, §1.2.1).[6] Additionally, nearly all particles that trigger ***n(t)***-prothesis also transform initial stops into post-stopped nasals (including initial [t̪^{h}∼t^{jh}] resulting from *t*-substitution of radical /s∼ʃ/), e.g. *cat* [k^{h}a^{h}t̪] 'cat', *an cat* [ə ŋ^{gɦ}a^{h}t̪] 'the cat', *baile* [pal^{j}ə] 'town', *am baile* [ə m^{b}al^{j}ə] 'the town', which implies the insertion of a homorganic nasal consonant. Prothetic consonants do not occur if the following word does not begin with a vowel or – in the case of ***n(t)***-prothesis – a stop consonant.[7]

[6]In most other dialects, ***n***-prothesis is realised as a pure nasal [N∼N^{j}]. The implied cluster /Nt̪∼N^{j}t^{j}/ in the system described by Oftedal (1956) is a specific quirk of Lewis Gaelic and some dialects of Skye (Borgstrøm 1941). Recall from ch. 1, §1.2.1 that post-stopping appears to have been lost in present-day Lewis Gaelic, meaning that the outcome of such a cluster would be a pure nasal [N∼N^{j}] in any case.

[7]Oftedal (1956) and many other authors regard ***n***-prothesis of initial stops as another initial mutation, often referred to as *nasalisation*. However, it is simpler to analyse it as a prothetic consonant that happens to surface before stops as well as vowels. For the historical development of this phenomenon, and its complicated relationship to the Irish *eclipsis* mutation, *see* Ó Maolalaigh (1995).

Table 5.7: Prothetic consonants

	Prothetic C
***N*-prothesis**	Nᵈ̪~Nᵈʲ /Nt̪~Nʲtʲ/
***Nt*-prothesis**	Nᵈ̪ʱ~Nᵈʲʱ /Nt̪ʰ~Nʲtʲʰ/
***H*-prothesis**	h
***Dh*-prothesis**	ɣ~j
***G*-prothesis**	k~kʲ

By virtue of the fact that they are realised only when the immediately-following word begins with a certain segment – in most cases a vowel – these prothetic consonants are clearly reminiscent of the *liaison* consonants of French. In line with the classic autosegmental approach to French liaison (Tranel 1995; Wetzels 2002; Bermúdez-Otero 2018a), I analyse prothetic consonants in Scottish Gaelic as underlyingly floating consonants which, whenever the phrase-level phonology permits it, dock to the initial onset of the following word. The underlyingly floating status of these consonants is supported by the same type of evidence as that discussed by Wetzels (2002: 290, 293 ff.) and Bermúdez-Otero (2018a: 19 ff.) for French liaison consonants. In French, an intonational break may occur between a liaison consonant and its preceding host word, which can be ascribed to faithfulness to the position of the right edge of the intonational phrase in the phrase-level input. Similarly, I have very frequently heard forms such as *ann an … Alba* [aNə || NaLapə] 'in … Scotland', *gun … cùm e* [kə || ŋʱɔum a] 'that … he will keep', where *n*-prothesis acts upon *Alba* [aLapə] 'Scotland', *cùm* [kʰɔum] 'keep' respectively across an intonational break.

5.2.4 Data set

The main empirical focus of this paper is the degree to which the slenderness of a stressed vowel is predictable from its (underlying) consonantal environment. In order to investigate this in more detail, a count was carried out of word-forms cited in Oftedal's (1956) detailed descriptive study of the dialect of Leurbost, Lewis. This count included all forms with a single stress on the initial syllable, which is true of the overwhelming majority of words in Scottish Gaelic. Forms with non-initial stress, or more than one stress, were not included since not enough data is available for a complete treatment of these types.[8]

[8] Words containing *svarabhakti groups*, i.e. VCV sequences in which the second vowel is a copy of the first and stress is spread evenly across both vowels, were included since I regard these sequences as

All unique word-forms explicitly cited either in the body of the text or in the index were counted, including inflected forms, mutated forms and forms with prothetic consonants, as long as they are transcribed as single words by Oftedal.[9] The sample texts were not searched, since this would have been a highly labour-intensive process and it was judged unlikely to yield a significant number of forms not cited elsewhere in the book. When two variant forms of a word were cited, both were normally included as two separate entries, e.g. both [ahərʲ] and [aharʲ] for *athair* 'father'. However, the many words with unstable final [ə], e.g. *oidhche* [ɤixʲ∼ɤixʲə] 'night', were only counted once in order to avoid excessive duplication. Homophonous forms were counted only once, unless they represented distinct underlying forms – for instance, *luath* [Luə] 'ash' and *luath* [Luə] 'quick' correspond to only one entry in the data set, whereas *-n deach* [Nᵈʲɛx] 'go.PST.DEP' and *-n each* [Nᵈʲɛx] 'horse' are listed separately because they are *n*-prothesised forms of *deach* [tʲɛx] and *each* [ɛx] respectively. A total of 3,259 forms were counted.[10]

5.3 Slenderness agreement

Slenderness agreement (henceforth SA) refers to the strong tendency in Scottish Gaelic for stressed vowels to agree in slenderness with an immediately-preceding broad or slender (i.e. coronal or dorsal) consonant. In other words, broad vowels normally occur after broad consonants and slender vowels after slender consonants. In words that conform to SA, the slenderness of the vowel is predictable from the slenderness of the preceding consonant. It follows that [±front] need not be specified on the vowel in the underlying representation, but rather can be assumed to spread from the preceding consonant by default. In this section I discuss SA and two classes of regular

phonologically monosyllabic, in agreement with Oftedal and many others (Hind 1996; 1997; Ladefoged et al. 1998; Hall 2003; 2006; Ladefoged 2003; Wentworth 2005; Iosad 2015; *see* ch. 4). Words belonging to the closed class of mostly adverbial forms with unstressed initial [ə] were included, without the [ə], because Oftedal transcribes [ə] as a separate word in these forms.

[9]Oftedal transcribes as single words a handful of forms containing the pre-vocalic allomorphs of the possessive particles *mo* [mə] and *do* [t̪ə], e.g. *m' athair* [mᵇahərʲ] 'my father', *d' athair* [t̪ahərʲ] 'your father'. Since [mᵇ] and [t̪] here do not behave like prothetic consonants, I consider them separate words and therefore do not count these forms separately.

[10]While all token counts are based exclusively on those forms explicitly cited in Oftedal (1956), it was not always possible to find suitable illustrative examples of specific phenomena in this source, e.g. mutated forms of stems of a particular phonological shape. Some of the examples cited in the remainder of this paper are therefore taken from other sources or from my own general knowledge of Lewis Gaelic, as long as I see no reason to suspect that the form in question might not be equally valid for the Leurbost system. Whenever an example contains a form not explicitly cited by Oftedal (1956), this will be noted.

exceptions to the rule. §5.3.1 provides token counts showing that we can account for the slenderness of the stressed vowel in 91.3% of those forms in which the preceding consonant is overtly either broad or slender. At this stage we will not consider neutral consonants (i.e. labials or [h]), which are neither overtly broad nor slender and may freely be followed by either broad or slender vowels.

Both classes of regular exceptions to SA involve cases in which broad vowels are preceded by slender consonants. First of all, rounded broad vowels may freely follow either broad or slender consonants. Recall from §1.2.2, however, that *all* rounded vowels are broad, meaning that roundedness is sufficient to predict that a vowel will be broad. A vowel that is [+round] therefore need not be specified for [±front] in the underlying representation. Even if the preceding consonant is [+front], the fact that the vowel is [+round] overrides SA and forces it to be [−front].

Secondly, an open vowel before a velarised consonant must always be broad [a(ː)] rather than slender [ɛ(ː)] in Lewis Gaelic, regardless of the slenderness of the preceding consonant.[11] This rule means that a following velarised consonant is sufficient to predict that a [+low] vowel will be broad, so it again need not be specified for [±front] in the underlying representation. Even if the preceding consonant is [+front], the presence of a following velarised consonant overrides SA and forces the vowel to be [−front], a process which I refer to as *anticipatory broadness spreading* (henceforth ABS).

Recall from §1.2.2 that the only *u*-diphthongs in Lewis Gaelic are broad [au ɔu]. Notice in particular that there is no slender *[ɛu] to oppose broad [au] in this dialect. Even if the preceding consonant is [+front] and the first element of the diphthong is [−round], the fact that the second element of the diphthong is [u] overrides SA and forces the first element to be [−front]. This can be regarded as a form of ABS operating within the diphthong, such that an immediately-following [u] has the same effect on [a] as would a following velarised consonant.

To sum up, the rule can be stated as follows:

(6) a. A stressed vowel that is rounded is broad.

[11] The data set contains six forms in which slender [ɛ] occurs before a velarised consonant. All but one are transparent English or Scots loans, e.g. *peantadh* [pʰɛN̥t̪əɣ] 'paint.VN', which can be assumed not to have fully assimilated to the Scottish Gaelic phonological system. The only such native form is *cheart* [xʲɛʂˠt̪ˠ] 'just', which is also cited as [xʲaʂˠt̪ˠ] with broad [a] – it is possible that the former transcription is an error, since Oftedal (1956: 58) explicitly states that [ɛ] is impossible here except in recent loans.

b. A stressed open vowel that is followed by a velarised consonant or is part of a *u*-diphthong is broad.

c. Other stressed vowels agree in slenderness with an immediately-preceding broad or slender consonant.

Broad vowels that are compelled to be broad by (6a) or (6b) will be referred to as *forced* broad vowels. These vowels are necessarily broad, even if preceded by a slender consonant. Other broad vowels, which are broad usually as a result of (6c), are *unforced*. There are therefore four types of form that can be considered regular according to the rule in (6): (a) those with a broad consonant followed by an unforced broad vowel, (b) those with a slender consonant followed by a slender vowel, (c) those with a broad consonant followed by a forced broad vowel, and (d) those with a slender consonant followed by a forced broad vowel:

(7) a. Broad C + unforced broad V

coille	[kʰɤLʲə]	‘wood’	*làmh*	[Laːv]	‘hand’
dath	[t̪a]	‘colour’	*naomh*	[Nɤːv]	‘holy’
gaoth	[kɯː]	‘wind’	*tuig*	[t̪ʰɯkʲ]	‘understand’

b. Slender C + slender V

cèir	[kʲʰeːrʲ]	‘wax’	*nighean*	[Nʲi.un]	‘girl’
deas	[tʲɛs]	‘south’	*sèimh*	[ʃɛːv]	‘quiet’
leth	[Lʲe]	‘half’	*tìr*	[tʲʰiːrʲ]	‘land’

c. Broad C + forced broad V

coire	[kʰɔrʲə]	‘kettle’	*lùdag*	[Luːt̪ak]	‘little finger’
crannchar	[kʰraNaxər]	‘fate’	*salach*	[saLəx]	‘dirty’
dall	[t̪auL]	‘blind’	*sònraichte*	[soːrixʲtʲ]	‘special’
dòigh	[t̪ɔːj]	‘way’	*tarraing*	[t̪ʰaRikʲ]	‘pull’
gàrradh	[kaːRəɣ]	‘wall’	*tobair*	[t̪ʰopərʲ]	‘well’
guth	[ku]	‘voice’			

d. Slender C + forced broad V

ceann	[kʲʰauN]	‘head’	*gearradh*	[kʲaRəɣ]	‘cut.VN’
ceannach	[kʲʰaNəx]	‘buy.VN’	*liùgh*	[Lʲuː]	‘pollock’

ceàrr	[kʲʰaːR]	‘wrong’	*neo*	[Nʲo]	‘or’
ceò	[kʲʰɔː]	‘mist’	*seo*	[ʃɔ]	‘this’
deònach	[tʲoːnəx]	‘willing’	*tiugh*	[tʲʰu]	‘thick’
geal	[kʲaL]	‘white’			

The stressed vowel in these forms need not be specified for [±front] in the underlying representation. In addition, however, there are occasional exceptional forms in which either a broad consonant is followed by a slender vowel, e.g. *dè* [t̪eː] ‘what’, or a slender consonant is followed by an unforced broad vowel, e.g. *teine* [tʲʰanə] ‘fire’. Only in these forms must the stressed vowel be lexically specified for [±front].

5.3.1 Token counts

Among those forms in the data set where the stressed vowel is immediately preceded by a broad or slender consonant, and leaving aside those in which the immediately-preceding consonant is neutral, the rule in (6) accounts for the slenderness of the vowel in 91.3% of cases. This means that the vowel need not be specified for [±front] in the overwhelming majority of underlying forms. A breakdown is provided in Table 5.8, which displays the numerical distribution of tokens of each vowel after broad and slender consonants, with separate counts for [a(ː)] when it is followed by a velarised consonant. Regular forms, displayed in blue, are those in which the slenderness of the vowel is correctly predicted by the rule in (6), i.e. forms with a broad consonant followed by an unforced broad vowel, forms with a slender consonant followed by a slender vowel, and forms with a broad or slender consonant followed by a forced broad vowel. Exceptional forms, displayed in red, are those in which either a broad consonant is followed by a slender vowel, or a slender consonant is followed by an unforced broad vowel.

This token count should be regarded as provisional, since all forms here are coded according to the surface slenderness value of the initial consonant. In the following section, we will see that some of these forms are actually regular once the underlying slenderness value of the initial consonant is taken into account.

Table 5.8: The numerical distribution of tokens of each vowel after broad and slender consonants. Cˠ stands for any velarised consonant.

V	Preceding C: Broad	Preceding C: Slender	Total	Regular	Exceptional
[ɯ]	54	5	59	54 (91.5%)	5 (8.5%)
[ɯː]	50	2	52	50 (96.2%)	2 (3.8%)
[ɤ]	58	38	96	58 (60.4%)	38 (39.6%)
[ɤː]	22	0	22	22 (100.0%)	0 (0.0%)
[ɤi]	63	6	69	63 (91.3%)	6 (8.7%)
[a]	212	27	239	212 (88.7%)	27 (11.3%)
[aː]	121	1	122	121 (99.2%)	1 (0.8%)
[ai]	25	1	26	25 (96.2%)	1 (3.8%)
[i]	14	105	119	105 (88.2%)	14 (11.8%)
[iː]	9	37	46	37 (80.4%)	9 (19.6%)
[iə]	5	65	70	65 (92.9%)	5 (7.1%)
[ia]	3	34	37	34 (91.9%)	3 (8.1%)
[e]	12	65	77	65 (84.4%)	12 (15.6%)
[eː]	9	55	64	55 (85.9%)	9 (14.1%)
[ei]	0	14	14	14 (100.0%)	0 (0.0%)
[ɛ]	39	75	114	75 (65.8%)	39 (34.2%)
[ɛː]	8	8	16	8 (50.0%)	8 (50.0%)
[u]	142	17	159	159 (100.0%)	0 (0.0%)
[uː]	52	17	69	69 (100.0%)	0 (0.0%)
[ui]	5	0	5	5 (100.0%)	0 (0.0%)
[uə]	52	0	52	52 (100.0%)	0 (0.0%)
[ua]	6	0	6	6 (100.0%)	0 (0.0%)
[o]	67	3	70	70 (100.0%)	0 (0.0%)
[oː]	27	5	32	32 (100.0%)	0 (0.0%)
[ɔ]	151	17	168	168 (100.0%)	0 (0.0%)
[ɔː]	54	21	75	75 (100.0%)	0 (0.0%)
[ɔu]	21	11	32	32 (100.0%)	0 (0.0%)
[a(Cˠ)]	35	45	80	80 (100.0%)	0 (0.0%)
[aː(Cˠ)]	15	15	30	30 (100.0%)	0 (0.0%)
[au]	28	18	46	46 (100.0%)	0 (0.0%)
	1359	**707**	**2066**	**1887 (91.3%)**	**179 (8.7%)**

5.4 Underlying slenderness

In this section I show how the slenderness value of a consonant on the surface may differ from that of its underlying form. This means that, under certain circumstances, the slenderness of the following vowel can be regarded as predictable from the underlying slenderness of the consonant even though they do not transparently agree on the surface. §5.4.1 discusses cases in which broad lenis [n], which does not have a slender counterpart on the surface, can be taken to represent an underlyingly slender consonant. §5.4.2 considers whether the same can be said for broad fortis [R] and the broad clusters [t̪ʰr t̪r st̪r], which also have no slender counterparts, but concludes that this is not the case. §§5.4.3–5.4.5 argue that initial neutral consonants can be taken to be either broad or slender underlyingly, and that this analysis should be extended to vowel-initial words as well by positing an initial underspecified consonant bearing slenderness features. §5.4.6 provides token counts showing that, given the correct underlying representations, we can account for the slenderness of the stressed vowel in 94.3% of all forms on the basis of the underlying slenderness of the initial consonant.

5.4.1 Underlying slender quality in [n]

Recall from §5.2.2 that broad lenis [n] is the lenited counterpart of both initial broad [N sN] and initial slender [Nʲ ʃNʲ], and therefore has no slender counterpart in initial position. Lenition of radical /Nʲ ʃNʲ/ thus entails the conversion of a slender consonant into a broad one. Consider the lenition of (a) slender [Nʲ ʃNʲ] before a slender vowel, and (b) slender [Nʲ ʃNʲ] before a forced broad vowel:[12]

(8)		**Radical**			**Lenited**		
	a.	[Nʲ ʃNʲ] + slender V			[n] + slender V		
		nigh	[Nʲi]	'wash.VN'	*nigh*	[ni]	(PST)
		nighean	[Nʲi.un]	'girl'	*nighean*	[ni.un]	
		sneachd	[ʃNʲɛxk]	'snow'	*shneachd*	[nɛxk]	
		snèap	[ʃNʲɛːʰp]	'turnip'	*shnèapaichean*	[nɛːʰpixʲən]	(PL.GEN)
	b.	[Nʲ] + forced broad V			[n] + forced broad V		
		neart	[Nʲaʂˠʈˠ]	'strength'	*neart*	[naʂˠʈˠ]	
		neònach	[Nʲoːnəx]	'strange'	*neònach*	[noːnəx]	

Note in particular that when the following vowel is slender, as in the forms in (8a), it remains slender in the lenited forms despite now being preceded by a broad consonant. SA is therefore sensitive to the slenderness of the radical initial consonant even in lenited forms. Since it is ordered before inflectional operations, SA must belong to the stem-level phonology.

This broadening of radical /Nʲ/ under lenition can be ascribed to the same word-level ban on slender lenis *[nʲ] that is responsible for the fortition of stem-final /n/

[12] The lenited forms *neart* [naʂˠʈˠ] and *neònach* [noːnəx] are not explicitly cited in Oftedal (1956), but I have no doubt that they are correct for Lewis Gaelic in general. As for an example of [ʃNʲ] before a forced broad vowel, consider the Ness pronunciation of *sneachd* [ʃNʲaxk], lenited *shneachd* [naxk] – in Ness, [x] triggers ABS in the same manner as a velarised consonant (*see* §5.5.1).

to [Nʲ] under slenderisation – only the chosen repair is different, depending on the position of the segment within the word. Importantly, this shows that forms such as [ni], [nɛxk] are not exceptions to SA, since there is independent evidence from alternations that the initial consonant is slender at the stem level in these items.

The existence of this word-level broadening process means that this analysis can now be extended to those occasional items that display non-alternating initial [n] followed by a slender vowel, e.g. *nì* [niː] 'do.NPST', by assuming that [n] here represents an underlyingly slender lenis /nʲ/. Independent evidence for the existence of /nʲ/ in underlying forms comes from forms such as *muin* [muNʲ] 'back', in which the final nasal is fortis on the surface yet fails to trigger *lengthening* of a preceding tautosyllabic vowel – again *see* ch. 4, §4.4 for an analysis in which lengthening occurs only if the triggering sonorant is already fortis in the stem-level output.

Finally, in order to complete the picture, we would need to look at the lenition of exceptional items in which /Nʲ ʃNʲ/ is followed by an unforced broad vowel. Unfortunately, there is insufficient data for forms of this type: the only such form cited in Oftedal (1956) is *neoichiontach* [NʲaxʲuN̥t̪əx] 'innocent', for which no lenited form is cited.

5.4.2 Absence of underlying slender quality in [R t̪ʰr t̪r st̪r]

Recall from §5.2.1 that broad fortis [R] and the broad initial clusters [t̪ʰr t̪r st̪r] do not have slender counterparts. However, a number of exceptional items occur in which these are followed by slender vowels:[13]

(9) a. [R] + slender V

rèidh [Rɛː] 'flat' *rìgh* [Riː] 'king'

b. [t̪ʰr] + slender V

treun [t̪ʰreːn] 'strong' *tric* [t̪ʰriʰkʲ] 'often'

c. [t̪r] + slender V

dreuchd [t̪riaxk] 'job' *dripeil* [t̪riʰpəL] 'busy'

d. [st̪r] + slender V

sreath [st̪rɛ] 'row' *strìpeach* [st̪riːʰpəx] 'whore'

[13] The form *dreuchd* [t̪riaxk] is not cited in Oftedal (1956).

If there was independent evidence that the initial consonants or clusters were underlyingly slender in these words, and were subject to broadening at the word level much like initial /nʲ/, then the slender quality of the vowel could be accounted for through SA at the stem level. However, the available evidence suggests that they in fact already broad in the stem-level output, meaning that these forms are exceptions to SA.

Taking first initial broad fortis [R], recall from §5.2.2 that its lenited counterpart is broad lenis [r]. Recall from §5.2.1, however, that [r] *does* have a slender counterpart [rʲ]. Although [rʲ] does not occur initially in native lexical roots, non-alternating forms such as the preposition *ri* [rʲi] show that there is no general phonotactic restriction on initial [rʲ]. If [R] were underlyingly slender in forms such as [Riː], and only became broad at the word level, we would therefore expect this hypothetical broadening process to be bled by lenition, yielding the lenited form *[rʲiː]. However, although Oftedal (1956) does not explicitly cite any forms of the relevant type, the outcome of lenition of /R/ is always broad [r] in Lewis Gaelic even when a slender vowel follows – *cf.* e.g. lenited *rìgh* [riː] in Borgstrøm (1940: 71) for Bernera, Lewis.[14] This shows that [R] is already broad in the stem-level output, so that forms such as [Riː] truly are exceptions to SA.

Evidence of the same type shows that [st̪r] is not underlyingly slender in forms such as *sreath* [st̪rɛ] 'row'. Recall from §5.2.2 that [st̪r] normally alternates with [r] under lenition, in which case I assume that it represents underlying /sR/ (although non-alternating items in "true" underlying /st̪r/ probably also exist, of which *strìpeach* [st̪riːʰpəx] 'whore' is likely to be an example based on its orthograhic form). If [st̪r] were underlyingly slender in words such as [st̪rɛ] then we would expect the lenited form *[rʲɛ]. Although we must again look elsewhere for an explicit example, the outcome of lenition of /sR/ is always broad [r] in Lewis Gaelic even when a slender vowel follows – *cf.* e.g. *srian* [st̪riən] 'bridle', lenited *shrian* [riən] in *SGDS* (s.v.). As with [Riː] above, this shows that forms such as [st̪rɛ] are exceptions to SA.

Turning now to [t̪ʰr], we know that it can in at least some cases represent an underlyingly slender cluster. Recall from §5.2.2 that the outcome of *t*-substitution of initial slender /ʃNʲ/ is broad [t̪ʰr] (ultimately [Nd̪ʱr] as a result of *n*-prothesis):

[14] A fossilised trace of slender [rʲ] from lenition of original */Rʲ/ after the vocative particle *a* [ə] occurs in the exclamation *A Rìgh!* [ə rʲiː] 'Oh Lord!', recorded by Borgstrøm (1937: 118–119; 1940: 165) for Barra.

(10) **Radical** **_T_-substituted (with _n_-prothesis)**

sneachd [ʃNʲɛxk] ‘snow’ *an t-sneachd* [ə Nᵈ̪ʱrɛxk] ‘the snow.PREP’

This shows that forms such as [Nᵈ̪ʱrɛxk] (from prothetic nasal + *t*-substituted [t̪ʰrɛxk]) need not be considered exceptions to SA, since [t̪ʰr] here represents an underlyingly slender cluster that only becomes broad as a result of initial mutation. However, there is evidence that [t̪ʰr] is not underlyingly slender in those forms where it does not result from *t*-substitution, such as *tric* [t̪ʰriʰkʲ] ‘often’. Recall from §5.2.2 that /t̪ʰ/ becomes [h] under lenition, including when it is the first member of a cluster. While the absence of slender *[t̪ʰrʲ t̪rʲ st̪rʲ] can all be ascribed to a single phonotactic constraint against [rʲ] after a coronal stop, there is no obvious reason why this restriction would also apply after [h], especially since [rʲ] may freely occur after other non-coronals. If [t̪ʰr] were underlyingly slender in forms such as [t̪ʰriʰkʲ], and only became broad at the word level because of a ban on [rʲ] after a coronal stop, then we would therefore expect this broadening process to be bled by lenition, yielding the lenited form *[hrʲiʰkʲ]. However, the outcome of lenition of /t̪ʰr/ is always broad [hr] in Lewis Gaelic even when a slender vowel follows – *cf.* e.g. lenited *thric* [hriʰkʲ] in Borgstrøm (1940: 79) for Bernera, Lewis. In the absence of any obvious reason for a phonotactic constraint to target the highly unnatural class of coronal stops and [h], by far the simplest explanation is simply that [t̪ʰr] – just like [R st̪r] – is already broad by the time lenition takes place. This shows that forms such as [t̪ʰriʰkʲ] must also be exceptions to SA.[15]

Finally, similar evidence shows that [t̪r] is not underlyingly slender in forms such as *dripeil* [t̪riʰpəL] ‘busy’. Recall from §5.2.2 that both /t̪/ and /k/ become [ɣ] under lenition, including when they are the first member of a cluster. The fact that radical initial /krʲ/ becomes [ɣrʲ] under lenition, e.g. *grian* [krʲiən] ‘sun’, lenited *ghrian* [ɣrʲiən], clearly demonstrates that there is no phonotactic restriction on initial [ɣrʲ]. This means that if [t̪r] were underlyingly slender in words such as [t̪riʰpəL], then we would expect the lenited form *[ɣrʲiʰpəL]. However, although the only relevant form explicitly cited by Oftedal (1956) is a transparent English loan and thus inconclusive,

[15] Note that I therefore predict that words in non-alternating initial [hrʲ] are theoretically possible, meaning that the absence of such forms must be considered accidental. Such an accidental gap is statistically unremarkable, given that non-alternating initial [h] is restricted to closed-class forms and loanwords.

the outcome of lenition of /t̪r/ is, to the best of my knowledge, always broad [ɣr] in Lewis Gaelic even when a slender vowel follows, e.g. lenited *dhripeil* [ɣriʰpəL].

5.4.3 Underlying slenderness in [h]

Recall from §5.2.2 that both broad /t̪ʰ s/ and slender /tʲʰ ʃ/ merge under lenition to [h], which is a neutral consonant and thus cannot faithfully reflect the slenderness of its underlying radical correspondent. This alternation therefore allows us to directly observe what happens when an underlyingly broad or slender consonant becomes neutral on the surface. Consider the lenition of (a) broad /t̪ʰ s/ before an unforced broad vowel, (b) slender /tʲʰ ʃ/ before a slender vowel, (c) broad /t̪ʰ s/ before a forced broad vowel, and (d) slender /tʲʰ ʃ/ before a forced broad vowel:

(11)	**Radical**			**Lenited**		
a.	[t̪ʰ s] + unforced br. V			[h] + unforced br. V		
	sadadh	[sat̪əɣ]	‘throw.VN’	*shad*	[hat̪]	(PST)
	tuig	[t̪ʰɯkʲ]	‘understand’	*thuig*	[hɯkʲ]	(PST)
b.	[tʲʰ ʃ] + sl. V			[h] + sl. V		
	seasamh	[ʃɛsu]	‘stand.VN’	*sheasamh*	[hɛsu]	
	tilleadh	[tʲʰiLʲəɣ]	‘return.VN’	*thilleadh*	[hiLʲəɣ]	
c.	[t̪ʰ s] + forced br. V			[h] + forced br. V		
	salach	[saLəx]	‘soil.VN’	*shalaich*	[haLixʲ]	(PST)
	tòiseachadh	[t̪ʰɔːʃəxəɣ]	‘start.VN’	*thòisich*	[hɔːʃixʲ]	(PST)
d.	[tʲʰ ʃ] + forced br. V			[h] + fr. glide + forced br. V		
	sealladh	[ʃaLəɣ]	‘look.VN’	*shealladh*	[he̯aLəɣ]	
	tionndadh	[tʲʰɔuN̥t̪aɣ]	‘turn.VN’	*thionndaidh*	[he̯ɔuN̥t̪aj]	(PST)

Notice that the slenderness contrast between the initial radical consonants in (11a) and (11b) – where the following vowel is free to participate in SA – is reflected only in the quality of the following vowel in the corresponding lenited forms. This shows that lenition of /t̪ʰ tʲʰ s ʃ/ feeds a phonological process, which I will refer to as *slenderness neutralisation* (henceforth SN), that deletes underlying [±front] from [h] and renders it neutral. However, since it has already been established that SA occurs in the stem-level phonology, before lenition takes place, the quality of the vowel reflects the slenderness of the underlying radical consonant and is unaffected by SN. Morphological alternations therefore provide us with direct evidence that the opposition between e.g. [hat̪] vs. [hɛsu] – realised on the surface as one between a broad and a slender vowel preceded by a neutral consonant – is in fact underlyingly a contrast between a broad and a slender initial consonant.

On the other hand, notice that the slenderness contrast between the initial radical consonants in (11c) and (11d) – where the following vowel is a forced broad vowel and thus cannot participate in SA – is reflected in the absence or presence of a front glide in the corresponding lenited forms. This shows that SN is accompanied by another phonological process, which I will refer to as *front glide epenthesis* (henceforth FGE), that serves to faithfully preserve underlying [+front] in exactly those cases where it is not shared with the following vowel. Morphological alternations therefore provide us with direct evidence that the opposition between e.g. [haLixʲ] vs. [he̯aLəɣ] – realised on the surface as the absence or presence of a front glide intervening between a neutral consonant and a forced broad vowel – is again underlyingly a contrast between a broad and a slender initial consonant, and that a front glide is the surface realisation of underlying slender quality in the initial consonant whenever roundedness or ABS forces the vowel to be broad.[16]

We are now equipped to set up correct underlying representations for those occasional forms in non-alternating [h], e.g. *fhathast* [ha.əst̪] 'yet', *(na) Hearadh* [(nə) hɛrəɣ] 'Harris', where alternations offer no independent evidence for the underlying slenderness of the initial consonant. These forms can be assumed to contain initial underlying broad /h/ and slender /hʲ/ respectively, parallel to the transparent opposition between e.g. [sat̪əɣ] vs. [ʃɛsu] in (11). This means that the slenderness of the vowel reflects the underlying slenderness of the preceding consonant and therefore need not be specified in the underlying representation.

As for exceptional items, the data set contains no straightforward examples of the lenition of forms in which broad /t̪ʰ s/ is followed by a slender vowel. On the other

[16]Oftedal (1956) cites two forms in which a front glide – always written as *j* in his struturalist phonemic notation – occurs before [ɛ]. However, since he explains elsewhere (p. 130) that this glide is generally realised as height-harmonic with the following vowel, it is not actually clear what the resulting sequence – *jɛ* in his notation – is supposed to represent phonetically. These highly anomalous forms are excluded from the data set.

hand, there is one example of the lenition of an exceptional form in which slender /t^{jh} ʃ/ is followed by an unforced broad vowel, *viz. teine* [t^{jh}anə] ‘fire’, whose lenited form *theine* is cited as both [hɛnə] and [he̯anə]. This suggests that, in cases where the following vowel is broad only by virtue of its underlying lexical specification, there is variation with respect to whether faithful preservation of underlying [+front] is achieved by making the vowel slender or through FGE.

5.4.4 Underlying slenderness in labials

The question of whether labial consonants can be said to participate in the broad–slender contrast in Scottish Gaelic, as they do straighforwardly in Irish, has been a subject of debate in the past (Fraser 1938: 95; Borgstrøm 1940: 18–19; MacAulay 1962: 174–175, 1966; Oftedal 1963; Jackson 1967; Ternes 1973: 32 ff.). Although they are neutral on the surface, there is evidence that they are either broad or slender underlyingly. Consider the distribution of broad vowels, slender vowels and front glides after labial consonants. A labial consonant may normally be followed by (a) an unforced broad vowel, (b) a slender vowel, (c) a forced broad vowel, or (d) a front glide + a forced broad vowel:

(12) a. Labial + unforced broad V

baile	[pal^{j}ə]	‘town’	*pasgadh*	[p^{h}askəɣ]	‘fold.VN’
bhaile	[val^{j}ə]	‘town’ (lenited)	*smaoinich*	[smɤːN^{j}ix^{j}]	‘think’
fasgadh	[faskaɣ]	‘shelter’	*spaid*	[spat^{j}]	‘spade’
maoil	[mɤːl^{j}]	‘bald’			

b. Labial + slender V

bean	[pɛn]	‘wife’	*peirceall*	[p^{h}er̥^{j}k^{j}əL]	‘jaw’
bhean	[vɛn]	‘wife’ (lenited)	*smior*	[smir]	‘marrow’
fear	[fɛr]	‘man’	*speur*	[speːr]	‘sky’
mìle	[miːl^{j}ə]	‘thousand’			

c. Labial + forced broad V

balach	[paLəx]	‘boy’	*pucaid*	[p^{h}u^{h}kat^{j}]	‘bucket’
bhalach	[vaLəx]	‘boy’ (lenited)	*smùr*	[smuːr]	‘dust’
fuirich	[fur^{j}ix^{j}]	‘stay’	*sporan*	[spɔran]	‘purse’

mala	[maLə]	‘eyebrow’			

d. Labial + front glide + forced broad V

beart	[pɛ̯aʂˠʈˠ]	‘loom’	*piuthar*	[pʰi̯u.ər]	‘sister’
bheart	[vɛ̯aʂˠʈˠ]	‘loom’ (lenited)	*smeòrach*	[sme̯oːrəx]	‘thrush’
feòil	[fɛ̯ɔːlʲ]	‘meat’	*speal*	[spɛ̯aL]	‘scythe’
mealladh	[mɛ̯aLəɣ]	‘deceive.VN’			

This distribution is exactly parallel to the distribution of broad vowels, slender vowels and front glides after [h]. Notice in particular the presence of a front glide intervening between a labial and a following forced broad vowel in the forms in (12d). Since it was established in the preceding section that a front glide after [h] serves to faithfully preserve underlying [+front] in the consonant when this is not shared with the following vowel, it is maximally economical to apply the same analysis to labials. I therefore assume that the opposition between the forms in (12c) and (12d), e.g. [paLəx] vs. [pɛ̯aʂˠʈˠ], is underlylingly one between a broad and a slender initial consonant, exactly parallel to the opposition between e.g. [haLixʲ] vs. [hɛ̯aLəɣ] in the previous section.[17] SN and FGE target underlyingly broad and slender labials in exactly the same manner as underlying /h⁽ʲ⁾/.

This now allows us to set up correct underlying representations for the forms in (12a) and (12b), which can be assumed to contain underlying broad and slender labials respectively. The opposition between e.g. [palʲə] vs. [pɛn] is therefore, once again, underlyingly one between a broad and a slender initial consonant, this time parallel to the opposition between e.g. [hat̪] vs. [hɛsu] in the previous section. The vowel in these forms is free to participate in ordinary SA at the stem level, before the preceding labial consonant subsequently undergoes SN later in the derivation. The slenderness of the vowel reflects the underlying slenderness of the preceding consonant and therefore need not be specified in the underlying representation.

For initial [f], alternations triggered by prothetic consonants provide independent evidence for its underlyingly broad or slender status. Recall from §5.2.3 that prothetic

[17] Indeed some authors, such as Ladefoged et al. (1998) and Nance & Ó Maolalaigh (2019), actually transcribe straightforward palatalisation in these forms rather than a front glide, e.g. *mealladh* [mʲaLəɣ], *piuthar* [pʲʰu.ər] – while I believe that this is correct at an abstract phonological level, detailed accounts such as those by Borgstrøm (1940) and Oftedal (1956) make clear that this front glide is, on the surface, much more than the brief palatal offglide of an overtly slender consonant.

consonants are inserted in vowel-initial words, including those that are vowel-initial as a result of deletion of radical /f/ under lenition, and that most come in both a broad and a slender form. Both *n*-prothesis and *dh*-prothesis are triggered by certain particles that also simultaneously trigger lenition in the following word, the net result being an alternation between initial [f] and a prothetic consonant. This allows us to directly observe what happens when a labial consonant, which is neutral, alternates with a consonant that comes in both a broad and a slender form. Normally, (a) [f] before an unforced broad vowel alternates with a broad consonant, (b) [f] before a slender vowel alternates with a slender consonant, (c) [f] before a forced broad vowel alternates with a broad consonant, and (d) [f] + a front glide before a forced broad vowel alternates with a slender consonant:[18]

(13)	**Radical**			**Lenited with prothetic C**		
a.	[f] + unforced br. V			Br. C + unforced br. V		
	fasgadh	[faskaɣ]	‘shelter’	*an fhasgaidh*	[ə N$^{\mathrm{d}}$askaj]	‘the sh.GEN’
	fàdan	[faːt̪ən]	‘peat.PL’	*de dh’fhàdan*	[t̪ə ɣaːt̪ən]	‘of peat.PL’
b.	[f] + sl. V			Sl. C + sl. V		
	fear	[fɛr]	‘man’	*an fhear*	[ə N$^{\mathrm{dj}}$ɛr]	‘the man.PREP’
	fios	[fis]	‘knowledge’	*a dh’fhios*	[ə jis]	‘of knowledge’
c.	[f] + forced br. V			Br. C + forced br. V		
	falach	[faLəx]	‘hide.VN’	*dh’fhalaich*	[ɣaLixʲ]	(PST)
	fuirich	[furʲixʲ]	‘stay’	*dh’fhuirich*	[ɣurʲixʲ]	(PST)
d.	[f] + fr. glide + forced br. V			Sl. C + br. V		
	feannag	[fɛ̯aNak]	‘lazybed’	*an fheannag*	[ə N$^{\mathrm{dj}}$aNak]	‘the lazybed’
	feòil	[fɛ̯ɔːlʲ]	‘meat’	*an fheòil*	[ə N$^{\mathrm{dj}}$ɔːlʲ]	‘the meat’

These alternations support the claim that the initial consonant is underlyingly broad in forms such as [faskaɣ] and [faLəx] and slender in forms such as [fɛr] and [fɛ̯aNak], and that the front glide is the surface realisation of underlying slender quality in a labial before a forced broad vowel. An obvious counter-proposal here would be that the underlying slenderness contrast belongs to the vowel in forms such as these, and

[18] The forms *feannag* [fɛ̯aNak] ∼ *an fheannag* [ə N$^{\mathrm{dj}}$aNak] are not cited in Oftedal (1956), but are discussed as an example in Oftedal (1963) and MacAulay (1966).

that the prothetic consonant simply takes its slenderness from the following vowel. However, parallel to those exceptional forms in which a slender vowel follows a broad consonant, e.g. *dè* [t̪eː] ‘what’, there are forms such as *faic* [feʰkʲ] ‘see’ but *chan fhaic* [xa Nᵈ̪eʰkʲ] ‘will not see’, in which [f] alternates with a broad prothetic consonant even though the following vowel is slender. The very existence of these exceptions to SA shows that the prothetic consonant must be taking its slenderness from an underlyingly broad initial /f/ rather than the vowel, which in turn allows us to account for the slenderness of the vowel through SA in all non-exceptional forms.

Similarly, parallel to those exceptional forms in which an unforced broad vowel follows a slender consonant, e.g. *teine* [tʲʰanə] ‘fire’, a handful of forms occur in which a front glide intervenes between a labial consonant and an unforced broad vowel, e.g. *beachd* [pe̯axk] ‘opinion’. However, the slenderness of the vowel appears to be highly unstable in at least some cases. For example, *bheachd*, the lenited form of *beachd*, is cited as both [vɛxk] and [ve̯axk], and the form *biorsamaid* [pi̯ɯʂˠəmatʲ] ‘spring balance’ is also cited as [piʂˠəmatʲ]. It may be that this is related to the variation noted in the previous section for *theine*, the lenited form of *teine* [tʲʰanə] ‘fire’, which occurs as both [hɛnə] and [he̯anə], i.e. there is variation with respect to whether preservation of underlying [+front] is achieved by making the vowel slender or through FGE, meaning that underlyingly broad vowels after underlyingly slender labials are only sometimes permitted to surface.[19]

5.4.5 Underlying slenderness in vowel-initial words

The one remaining environment in which a front glide may occur is word-initially. It turns out that the distribution of broad vowels, slender vowels and front glides in initial position is exactly parallel to their distribution after labials and [h], and that vowel-initial words display alternations with prothetic consonants identical to those observed with initial lenited /f/ + vowel. A word may normally begin with (a) an unforced broad vowel, which takes a broad prothetic consonant, (b) a slender vowel, which takes a slender prothetic consonant, (c) a forced broad vowel, which takes a broad prothetic consonant, or (d) a front glide + a forced broad vowel, in which case

[19]Note that in the case of *bheachd* [vɛxk]~[ve̯axk] we might instead be witnessing variation in the occurrence of ABS, since [x] is a regular trigger for ABS further north in Ness (*see* §5.5.1).

the front glide alternates with a slender consonant:[20]

(14)

	Without prothetic C			With prothetic C		
a.	Unforced br. V			Br. C + unforced br. V		
	ad	[at̪]	‘hat’	*an ad*	[ə Nᵈ̥at̪]	‘the hat’
	uinneag	[ɯNʲak]	‘window’	*an uinneag*	[ə Nᵈ̥ɯNʲak]	‘the window’
b.	Sl. V			Sl. C + sl. V		
	each	[ɛx]	‘horse’	*an each*	[ə Nᵈʲɛx]	‘the h.PREP’
	eumraich	[eːmrixʲ]	‘low.VN’	*ag eumraich*	[ə kʲeːmrixʲ]	‘lowing’
c.	Forced br. V			Br. C + forced br. V		
	arspag	[as̪ˠpak]	‘gull’	*an arspag*	[ə Nᵈ̥as̪ˠpak]	‘the gull’
	obair	[opərʲ]	‘work.VN’	*ag obair*	[ə kopərʲ]	‘working’
d.	Fr. glide + forced br. V			Sl. C + forced br. V		
	eallach	[ɛ̯aLəx]	‘load’	*an eallach*	[ə NᵈʲaLəx]	‘the load’
	ionnsaich	[ɛ̯ɔusixʲ]	‘learn’	*dh’ionnsaich*	[jɔusixʲ]	‘learn.PST’

Notice in particular the presence of an initial front glide before a broad vowel in the forms in (14d). Since a front glide in any other environment is the surface realisation of underlying slender quality in a preceding neutral consonant, I propose that the phonological representations of these forms contain an initial underspecified consonant [X]. I therefore assume that the opposition between the forms in (14c) and (14d), e.g. [Xas̪ˠpak], [Xɛ̯aLəx], is underlyingly one between initial broad /X/ and slender /Xʲ/. This makes it exactly parallel to the opposition between e.g. [haLixʲ] vs. [hɛ̯aLəɣ] or [paLəx] vs. [pɛ̯as̪ˠt̪ˠ] in the previous sections. /X⁽ʲ⁾/ is subject to SN and FGE in exactly the same manner as all other neutral consonants.

We may now set up correct underlying representations for the forms in (14a) and (14b), which can be assumed to contain underlying broad /X/ and slender /Xʲ/ respectively. The opposition between e.g. [Xat̪] vs. [Xɛx] is therefore parallel to the opposition between e.g. [hat̪] vs. [hɛsu] or [palʲə] vs. [pɛn] in the previous sections. Once again, the vowel in these forms is free to participate in ordinary SA at the stem level, before the preceding /X⁽ʲ⁾/ subsequently undergoes SN later in the derivation.

[20] The form *an arspag* [ə Nᵈ̥as̪ˠpak] is not explicitly cited in Oftedal (1956).

The slenderness of the vowel again reflects the underlying slenderness of the preceding consonant and need not be specified in the underlying representation.[21]

Rather than docking to a following onsetless syllable, as in the classic autosegmental approach to French liaison consonants, I assume that a prothetic consonant in Lewis Gaelic undergoes coalescence with initial /X∼Xʲ/. The prothetic consonant is underlyingly unspecified for slenderness, but takes on the slenderness of initial /X∼Xʲ/ when coalescence takes place. The alternations in (14) therefore support the claim that there is an underlyingly broad initial consonant in forms such as [Xat̪] and [Xas̪ˠpak] and an underlyingly slender one in forms such as [Xɛx] and [Xe̯aLəx], and that the front glide is the surface realisation of underlying slender quality in [X] before a forced broad vowel. Parallel to *faic* [feʰkʲ] 'see' in the previous section, exceptional forms such as *aiteamh* [Xɛʰtʲu] 'thaw.VN' but *ag aiteamh* [ə kɛʰtʲu] 'thawing', which takes a broad prothetic consonant even though the following vowel is slender, show that the prothetic consonant takes its slenderness from an underlyingly broad initial /X/ rather than the vowel.

For completeness, note that the data set contains no forms in which an initial front glide is followed by an unforced broad vowel, parallel to *beachd* [pe̯axk] 'opinion' in the preceding section.

The abstract initial consonant proposed here is far from unprecedented in the Goidelic languages, as there is powerful motivation for such a consonant in Irish. Irish has a number of particles whose final consonants alternate in slenderness much like the prothetic consonants of their Scottish Gaelic cognates. However, the slenderness of the consonant in Irish cannot ordinarily be predicted from the surface quality of the initial vowel. Cases of mismatch between the slenderness of the consonant and the slenderness of the initial vowel, in the style of Scottish Gaelic *ag aiteamh* [ə kɛʰtʲu] 'thawing', are therefore ubiquitous in Irish:

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[21] There are three forms in the data set in which FGE fails to occur before a stressed broad vowel even though prothesis shows that they begin with underlyingly slender /Xʲ/. In *earball* [ɯrɯpəL] 'tail' (*cf. an t-earball* [ə NᵈʲʱɯrɯpəL] 'the tail') it is possible that Oftedal has miscategorised slender [i] as broad [ɯ], as he notes that these two vowels are "often difficult to distinguish" in this particular environment (i.e. a svarabhakti group). If the vowel is actually slender [i] in the phonological surface representation then FGE is not expected to occur, even if it subsequently undergoes some degree of gradient retraction towards [ɯ] at the phonetic level. I believe a similar explanation may lie behind *eaglais* [ɤkLəʃ] 'church' (*cf. an eaglais* [ə NᵈʲɤkLəʃ] 'the church') and *feadhainn* [fɤɣəNʲ] 'some' (*cf. an fheadhainn sin* [ə NᵈʲɤɣəNʲ ʃin] 'those ones') – the former, at least, is also cited as [ekLəʃ], and some degree of retraction of slender /e/ towards [ɤ] before velar consonants is common in Lewis Gaelic (*see* e.g. Borgstrøm 1940: 29).

(15) **Irish** (Ní Chiosáin 1991)

a. Initial broad V takes broad C

ór	[oːrˠ]	‘gold’	*an óir*	[ən̪ˠ oːrʲ]	‘the gold.GEN’
áthas	[ɑːhəsˠ]	‘joy’	*an áthais*	[ən̪ˠ ɑːhɪʃ]	‘the joy.GEN’

b. Initial broad V takes slender C

eaglais	[ɑːgl̪ˠɪʃ]	‘church’	*an eaglais*	[ənʲ ɑːgl̪ˠɪʃ]	‘the church’
eolas	[oːl̪ˠəsˠ]	‘knowledge’	*an eolais*	[ənʲ oːl̪ˠɪʃ]	‘the kn.GEN’

c. Initial slender V takes broad C

aois	[iːʃ]	‘age’	*an aois*	[ən̪ˠ iːʃ]	‘the age’
uisce	[ɪʃkʲɪ]	‘water’	*an uisce*	[ən̪ˠ ɪʃkʲɪ]	‘the water.GEN’

d. Initial slender V takes slender C

inneall	[ɪnʲəl̪ˠ]	‘machine’	*an innill*	[ənʲ ɪnʲɪlʲ]	‘the m.GEN’
iontas	[iːn̪ˠt̪ˠəsˠ]	‘wonder’	*an iontais*	[ənʲ iːn̪ˠt̪ˠɪʃ]	‘the wonder.GEN’

Note that in the Scottish Gaelic cognates of these words, e.g. *òr* [ɔːr], *eòlas* [ɛ̯ɔːLəs], *uisge* [ɯʃkʲə], *inneal* [iNʲəL], the proposed underlying slenderness of initial [X] is reflected in the surface quality of the vowel as a result of SA and FGE, so it is only in exceptional forms such as *ag aiteamh* [ə kɛʰtʲu] that we see such direct evidence for an initial abstract consonant. However, due to the general unpredictability exemplified by the forms in (15), an analysis employing some kind of underspecified initial consonant is well-established for Irish (Gussmann 1986; Ní Chiosáin 1991: 78 ff.; Anderson 2016: 168). In addition, Anderson (2016) employs abstract consonants very much like those proposed in the present analysis in order to account for the slenderness of vowels in Old Irish, while a similar consonant in non-initial position is proposed by Clements (1986) and in ch. 4 in order to account for hiatus and the overapplication of vowel epenthesis in Scottish Gaelic.

Because prothetic consonants in Scottish Gaelic are sensitive to the underlying slenderness of /$f^{(j)}$ $X^{(j)}$/, the underlying slenderness of these consonants must be visible to the phrase-level phonology. This indicates that SN and FGE do not occur until the phrase level, at which stage underlying /$X^{(j)}$/ is subject to these processes unless it happens to coalesce with a prothetic consonant that is capable of taking on its underlying slenderness. Meanwhile, lenition of underlying /$f^{(j)}$/ yields [$X^{(j)}$] at the word level, which is then subject to exactly the same phrase-level processes as underlying /$X^{(j)}$/.[22]

5.4.6 Token counts

Now including forms with an initial neutral consonant, and taking into account the underlying representations established in the preceding sections, the rule in (6) now accounts for the slenderness of the vowel in 94.1% of cases. First of all, because SA occurs at the stem level, all mutated forms are now coded according to the slenderness of the initial consonant in the corresponding radical form, even if this differs from its slenderness on the surface. This affects items in broad [n] from lenition of slender /Nʲ ʃNʲ/, broad [t̪ʰr] from *t*-substitution of slender [ʃNʲ], and neutral [h] from lenition of broad /t̪ʰ s/ or slender /tʲʰ ʃ/. Secondly, forms in initial [f] or [X] are now coded accordingly whenever they are seen to alternate with a broad or slender prothetic consonant. Finally, because underlying slenderness in a neutral consonant is realised as a front glide whenever the following vowel is broad, a neutral consonant is coded as underlyingly broad if it is followed by a broad vowel without an intervening front glide, and as underlyingly slender if it followed by a front glide. Whenever underlying slenderness could be established in this way, it was assumed to be shared by all morphologically related forms present in the data set. Forms in which the underlying slenderness of the initial consonant cannot be established in this way are coded as "Unknown". This applies to those occasional forms in non-alternating initial [n], as well as all remaining forms in an initial neutral consonant followed by a slender vowel.

A breakdown is provided in Table 5.9, with regular and exceptional forms displayed in blue and red respectively as in Table 5.8. In addition to forms like *dè* [t̪eː] 'what' and *teine* [tʲʰanə] 'fire', exceptional forms now include those in which an unforced broad vowel is preceded by a neutral consonant + front glide, e.g. *beachd* [pe̯axk] 'opinion', or a slender vowel is preceded by a neutral consonant that can be

[22] To be precise, this applies to radical /$f^{(j)}$/ only when it is followed by a vowel. When a consonant follows, e.g. *freagair* [frɤkərʲ] 'answer', the lenited form patterns with consonant-initial words and is not susceptible to prothesis, e.g. *fhreagair* [rɤkərʲ] 'ask.PST', not **dh'fhreagair* *[ɣrɤkərʲ]. I therefore assume that lenition of /$f^{(j)}$/ before a consonant actually entails full deletion rather than replacement by [$X^{(j)}$]. Note that this stands in stark contrast to Irish, where cognate forms instead pattern with vowel-initial words in this respect, e.g. *freagair* [fʲrʲagərʲ] 'ask', *d'fhreagair* [dʲrʲagərʲ] 'ask.PST'.

Table 5.9: The numerical distribution of tokens of each vowel after broad consonants, slender consonants, and consonants whose underlying slenderness cannot be independently verified. Cˠstands for any velarised consonant.

V	Preceding C: Broad	Slender	Unknown	Total	Regular	Exceptional
[ɯ]	65	7	0	72	65 (90.3%)	7 (9.7%)
[ɯː]	67	2	0	69	67 (97.1%)	2 (2.9%)
[ɤ]	95	42	0	137	95 (69.3%)	42 (30.7%)
[ɤː]	39	2	0	41	39 (95.1%)	2 (4.9%)
[ɤi]	94	6	0	100	94 (94.0%)	6 (6.0%)
[a]	402	31	2	435	404 (92.9%)	31 (7.1%)
[aː]	192	1	0	193	192 (99.5%)	1 (0.5%)
[ai]	32	1	1	34	33 (97.1%)	1 (2.9%)
[i]	11	126	91	228	217 (95.2%)	11 (4.8%)
[iː]	8	40	25	73	65 (89.0%)	8 (11.0%)
[iə]	4	74	26	104	100 (96.2%)	4 (3.8%)
[ia]	3	39	8	50	47 (94.0%)	3 (6.0%)
[e]	17	71	49	137	120 (87.6%)	17 (12.4%)
[eː]	9	64	18	91	82 (90.1%)	9 (9.9%)
[ei]	0	16	7	23	23 (100.0%)	0 (0.0%)
[ɛ]	41	84	36	161	120 (74.5%)	41 (25.5%)
[ɛː]	8	9	9	26	18 (69.2%)	8 (30.8%)
[u]	238	27	0	265	265 (100.0%)	0 (0.0%)
[uː]	72	17	0	89	89 (100.0%)	0 (0.0%)
[ui]	7	0	0	7	7 (100.0%)	0 (0.0%)
[uə]	82	0	0	82	82 (100.0%)	0 (0.0%)
[ua]	16	0	0	16	16 (100.0%)	0 (0.0%)
[o]	98	3	0	101	101 (100.0%)	0 (0.0%)
[oː]	47	8	0	55	55 (100.0%)	0 (0.0%)
[ɔ]	220	18	0	238	238 (100.0%)	0 (0.0%)
[ɔː]	83	31	0	114	114 (100.0%)	0 (0.0%)
[ɔu]	28	17	0	45	45 (100.0%)	0 (0.0%)
[a(Cˠ)]	85	68	0	153	153 (100.0%)	0 (0.0%)
[aː(Cˠ)]	29	20	0	49	49 (100.0%)	0 (0.0%)
[au]	49	22	0	71	71 (100.0%)	0 (0.0%)
	2141	**846**	**272**	**3259**	**3066 (94.1%)**	**193 (5.9%)**

shown to be underlyingly broad, e.g. *faic* [feʰkʲ] 'see', *cf. chan fhaic* [xa N̥ᵈeʰkʲ] 'will not see'. Forms in which we can merely assume that the vowel takes its slenderness from the underlying initial consonant, since the slenderness of the latter cannot be independently verified using the available data, are displayed in green and counted as regular.

5.5 Constraint-based analysis

In this section I provide a constraint-based analysis of the relevant phonological processes in the framework of Stratal OT, showing how the observed surface forms are derived from the proposed underlying forms via several consecutive rounds of phonological processing acting first on the stem, then the word, and finally the utterance as a whole. First of all, §5.5.1 deals with the stem-level process of SA, and also discusses evidence that ABS is a word-level process. §5.5.2 and §5.5.3 then deal with the word-level processes of ABS and the broadening of initial /N^j/ under lenition, and §5.5.4 deals with the phrase-level processes of SN and FGE. Finally, §5.5.5 provides a summary of the full stratal derivations of all relevant form types.

5.5.1 Stem level: Slenderness agreement

It has been established that SA is a stem-level process, on the basis of the fact that it is sensitive to the slenderness of the radical initial consonant before initial mutation takes place. I assume that SA is motivated by a markedness constraint that demands agreement in V-place features between a consonant and an immediately-following vowel. I define this constraint as follows:

(16) AGREE(V-pl): Let CV be a sequence of a consonant and a vowel in the output. Assign a violation mark if there exists a V-place feature F such that F is linked to C but not V *or* F is linked to V but not C.

Since SA only occurs in stressed vowels, I assume that this constraint is outranked by other constraints responsible for the particular distribution of vowel qualities found in unstressed syllables.

Recall from §5.3 that SA is overridden by the requirement that a rounded vowel be broad, and the requirement that an open vowel be broad if it is followed by a segment that triggers ABS. The former is clearly motivated by a typologically well-motivated markedness constraint against non-back rounded vowels, which I define as follows:

(17) $[+\text{rd}]\rightarrow[-\text{fr}]$: Let V be a vowel in the output. Assign a violation mark if V is [+round] *and* V is not [$-$front].

I assume that all rounded vowels become broad at the stem level, since there is no evidence that non-broad rounded vowels persist into any later stage of the phonological derivation.

The motivation for ABS before velarised consonants and within *u*-diphthongs is less certain. It appears to be somewhat coincidental that the set of triggers for ABS in this particular dialect contains precisely the velarised consonants, which share a [u]-like component to their tongue position, and /u/ itself. As we travel southwards from Lewis through Harris, North Uist, Benbecula and South Uist until we reach Barra at the southern end of the Outer Hebrides, using forms from Borgstrøm (1937; 1940; largely supported by the same or similar headwords in *SGDS*), we find that the set of triggers gradually decreases in size. As the second element of a diphthong, /u/ triggers ABS only as far south as Harris, while dialects further south have e.g. *ceann* [k^{jh}ɛuN] 'head' vs. Leurbost [k^{jh}auN]. Meanwhile, /L R/ trigger ABS over a greater area, extending as far as South Uist, and only drop out of the set when we reach Barra, which has e.g. *ceàrr* [k^{jh}ɛːR] 'wrong', *geal* [k^{j}ɛL] 'white', *gearradh* [k^{j}ɛRəɣ] 'cut.VN' vs. Leurbost [k^{jh}aːR], [k^{j}aL], [k^{j}aRəɣ]. On the other hand, /N/ triggers ABS even in Barra, e.g. *ceannach* [k^{jh}aNəx] 'buy.VN'. Conversely, as we travel northwards through Lewis from Leurbost towards Ness at the far northern end of the island, the set of triggers expands to include /x/, e.g. *seachd* [ʃaxk] 'seven' vs. Leurbost [ʃɛxk]. ABS therefore appears to be triggered by a dialect-specific set of segments according to an implicational hierarchy /x/ > /u/ > /L R/ > /N/.

There is evidence that ABS is the result of a word-level process rather than a stem-level one. Since slenderisation of stem-final /N L/ to [N^{j} L^{j}] removes the triggering environment for this process, it is potentially possible to establish whether ABS is ordered before or after inflectional operations. If morphologically-triggered stem-final slenderness alternations are capable of feeding ABS alternations in a preceding vowel, then this indicates that ABS doesn't occur until the word level. Unfortunately, straightforward examples are difficult to come by due to complicating factors such as ablaut and lengthening, which frequently trigger additional alternations in the vowel. An informative example in the Leurbost data is the four-way alternation observed in *beinn* [peiN^{j}] 'mountain', genitive plural *beann* [pɛ̯auN], genitive singular *beinne* [pɛN^{j}ə], diminutive *beannan* [pɛ̯aNan]. In the first two forms, fortis [N^{j} N] in the coda trigger *i*- and *u*-diphthongisation respectively, feeding ABS in the latter case. In the last two forms, where [N^{j} N] are not in the coda, the alternation between [N^{j}] and [N] triggers a straightforward slenderness alternation in the preceding vowel. Another example can be found in the closely-related dialect of Ness, where, as mentioned above, the set of consonants that trigger ABS also includes /x/. In *each* [jax] 'horse', genitive *eich* [ɛx^j], the alternation between [x] and [x^j] again triggers the same alternation in the preceding vowel (recall from §1.2.2 that the front glide is merged with consonantal [j] in Ness). I therefore assume that these forms are subject to ordinary SA at the stem level, and thus have slender [ɛ] in the stem-level output, before subsequently undergoing ABS at the word level if the relevant triggering environment is present. As a word-level process, ABS will be dealt with in the following section.

The analysis also assumes the following standard faithfulness constraint types:

(18) a. DEP(S): Let S be a segment in the ouput. Assign a violation mark if S does not have an input correspondent.

b. MAX(F): Let F be a feature in the input. Assign a violation mark if F does not have an output correspondent.

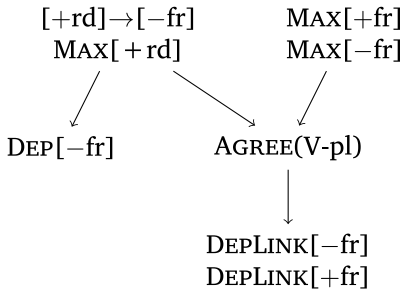
c. DEP(F): Let F be a feature in the output. Assign a violation mark if F does not have an input correspondent.

d. MAXLINK(F): Let S_I be a segment in the input and let S_O be its output correspondent. Assign a violation mark if S_I is linked to a feature F *and* S_O is not linked to F.

e. DEPLINK(F): Let S_I be a segment in the input and let S_O be its output correspondent. Assign a violation mark if S_O is linked to a feature F *and* S_I is not linked to F.

The observed patterns allow us to establish the the stem-level ranking in (19), as shown in the tableau in (20). Vowels are underlyingly unspecified for [±front] in non-exceptional forms, for which I employ archiphonemic notation: close, mid and open unrounded vowels are represented by /I E A/ respectively, and rounded vowels by /U O Ɔ/. First of all, if an unrounded vowel is unspecified for [±front] in the underlying form, as in input (a) for *dath* [t̪a] 'colour' and input (b) for *leth* [L^{j}e] 'half', the fully faithful candidates (a-i) and (b-i) violate high-ranked AGREE(V-pl) due to the presence of a V-place feature on the preceding consonant. [±front] therefore spreads from the preceding consonant at the expense of low-ranked DEPLINK[−fr] or DEPLINK[+fr] (a-ii,b-ii). This brings about the observed default pattern whereby a vowel agrees in slenderness with the immediately-preceding consonant, when other factors do not force it to be broad.

(19) Stem level



Secondly, if a vowel is rounded in the underlying form, as in input (c) for *guth* [ku] 'voice' and input (d) for *seo* [ʃɔ] 'this', the fully faithful candidates (c-i) and (d-i) violate not only Agree(V-pl) but also high-ranked [+rd]→[−fr] due to the presence of the feature [+round] on the vowel. In the former case, [−front] simply spreads from the preceding consonant as before, at the expense of low-ranked DepLink[−fr] (c-ii). In the latter case, however, spreading [+front] from the preceding consonant (d-ii) would still incur a violation of higher-ranked [+rd]→[−fr], and concomitant unrounding of the vowel (d-iii) would violate high-ranked Max[+rd]. [−front] is therefore epenthesised on the vowel (d-iv) at the expense of low-ranked Dep[−fr]. An alternative repair (d-v), in which [−front] links to both the vowel and the preceding consonant in order to satisfy Agree(V-pl), is ruled out by high-ranked Max[+fr]. This brings about the observed pattern whereby a rounded vowel is forced to be broad, regardless of the slenderness of the preceding consonant.

Finally, if a vowel is lexically specified for [±front] in the underlying form, as in input (e) for *dè* [t̪eː] 'what' and input (f) for *teine* [t^{jh}anə] 'fire', the fully faithful candidates (e-i) and (f-i) violate Agree(V-pl) due to the presence of opposing V-place features on the consonant and the following vowel. However, a repair in which [±front] spreads from the consonant onto the vowel (e-ii,f-ii) or vice-versa (e-iii,f-iii) is ruled out by high-ranked Max[+fr] and Max[−fr]. This brings about those occasional lexical exceptions in which either a broad consonant is followed by a slender vowel, or a slender consonant is followed by an unforced broad vowel.

At this stage of the derivation, all stems behave identically to one of the six forms shown in (20). All consonants, including those that are neutral on the surface, are either [+front] or [−front] in the stem level output. Unrounded vowels in non-exceptional stems, including those which subsequently undergo ABS, share [±front]

(20) Stem level

Input	Candidate	[+rd]→[−fr]	MAX[+rd]	MAX[+fr]	MAX[−fr]	DEP[−fr]	AGREE(V-pl)	DEPLINK[−fr]	DEPLINK[+fr]
a. t̪ A [−fr]	i. t̪ A [−fr]						*!		
	☞ ii. t̪ a [−fr]							*	
b. Lʲ E [+fr]	i. Lʲ E [+fr]						*!		
	☞ ii. Lʲ e [+fr]								*
c. k U [−fr]	i. k U [−fr]	*!					*		
	☞ ii. k u [−fr]							*	
d. ʃ Ɔ [+fr]	i. ʃ Ɔ [+fr]	*!					*		
	ii. ʃ œ [+fr]	*!							*
	iii. ʃ ɛ [+fr]		*!						*
	☞ iv. ʃ ɔ [+fr] [−fr]					*	*	*	
	v. s ɔ [−fr]			*!		*		**	
e. t̪ eː [−fr] [+fr]	☞ i. t̪ eː [−fr] [+fr]						*		
	ii. t̪ ɤː [−fr]			*!				*	
	iii. tʲ eː [+fr]				*!				*
f. tʲʰ a n ə [+fr] [−fr]	☞ i. tʲʰ a n ə [+fr] [−fr]						*		
	ii. tʲʰ ɛ n ə [+fr]				*!				*
	iii. t̪ʰ a n ə [−fr]			*!				*	

(22) Word level

$$\begin{array}{c}\text{ABS}\\ \downarrow\\ \text{DEPLINK}[-\text{fr}]\\ \text{MAXLINK}[+\text{fr}]\end{array}$$

with the preceding consonant, while all rounded vowels are [−front] regardless of the slenderness of the preceding consonant. In a minority of stems, *viz.* those lexically marked exceptions in which the vowel is underlyingly specified for [±front], an unrounded vowel bears a feature [±front] that is not shared with the preceding consonant.

5.5.2 Word level: Anticipatory broadness spreading

It was shown in the preceding section that ABS is a word-level process, on the basis of the fact that it may be bled by slenderisation. For our purposes here it will suffice to define the following markedness constraint to motivate ABS:

(21) ABS: Let VS be a sequence of a vowel and another segment, or the two elements of a diphthong, in the output. Assign a violation mark if V is [+low] *and* S is an ABS trigger *and* the feature [−front] that is linked to S is not also linked to V.

I assume that undominated faithfulness constraints protect whatever properties of velarised consonants and /u/ are responsible for triggering ABS. The observed patterns allow us to establish the word-level ranking in (22), as shown in the tableau in (23) for the proposed word-level input for *ceannach* [k^{jh}aNəx] 'buy.VN'. The fully faithful candidate (a) violates high-ranked ABS due to the presence of a slender vowel followed by an ABS trigger, so [−front] spreads from the latter onto the vowel (b) at the expense of low-ranked DEPLINK[−fr] and MAXLINK[+fr].

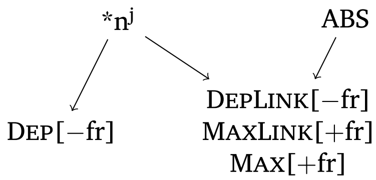
5.5.3 Word level: Broadening of initial /N^j/ under lenition

Recall from §5.4.1 that lenition of slender /N^j ʃN^j/ feeds a word-level process that broadens the initial nasal to [n]. This is driven by the same word-level ban on slender

(23) Word level

k^{jh} ɛ N ə x \/ \\ [+fr] [−fr]	ABS	DEP LINK [−fr]	MAX LINK [+fr]
a. k^{jh} ɛ N ə x \/ \\ [+fr] [−fr]	*!		
☞ b. k^{jh} a N ə x / \/ [+fr] [−fr]		*	*

(25) Word level



lenis *[nʲ] that is responsible for the fortition of stem-final /n/ to [Nʲ] under slenderisation. I define the following markedness constraint:

(24) *nʲ: Let S be a segment in the output. Assign a violation mark if S is [nʲ].

The observed patterns allow us to add to the word-level ranking in (22) to produce the ranking in (25), as shown in the tableau in (26) for items in initial /Nʲ/. The same analysis will also account for the broadening that occurs in the lenition of slender /ʃNʲ/ to [n] as well as, *mutatis mutandis*, the *t*-substitution of slender /ʃNʲ/ to [t̪ʰr]. I use [LEN] as a shorthand for the autosegmental feature bundle that is responsible for lenition, which before a coronal sonorant presumably selects an allomorph consisting of whatever feature distinguishes lenis coronal sonorants from fortis ones. For simplicity, I do not consider any candidate outputs in which this fails to dock to the initial consonant. In all cases, high-ranked *[nʲ] ensures that the initial nasal becomes broad. First of all, if [Nʲ] is followed by a slender vowel in the word-level input, as in input (a) for *nigh* [ni] 'wash.PST', the maximally faithful candidate (a-i) violates high-ranked *[nʲ]. [−front] is therefore epenthesised on the nasal (a-ii) at the expense of low-ranked DEP[−fr], DEPLINK[−fr] and MAXLINK[+fr].

Secondly, if [Nʲ] is followed by a rounded broad vowel in the word-level input, as in input (b) for *neònach* [noːnəx] 'strange' (lenited), the maximally faithful candidate (b-i) again violates *[nʲ]. [−front] therefore spreads from the following vowel onto the nasal (b-ii) at the expense of low-ranked DEPLINK[−fr], MAXLINK[+fr] and MAX[+fr].

(26) Word level

		*nʲ	ABS	DEP[−fr]	DEPLINK[−fr]	MAXLINK[+fr]	MAX[+fr]
a. [LEN]+ Nʲ i ([+fr] linked to Nʲ and i)	i. nʲ i ([+fr] linked to nʲ and i)	*!					
	☞ ii. n i ([−fr] linked to n, [+fr] linked to i)			*	*	*	
b. [LEN]+ Nʲ oː n ə x ([+fr] linked to Nʲ, [−fr] linked to oː)	i. nʲ oː n ə x ([+fr] linked to nʲ, [−fr] linked to oː)	*!					
	☞ ii. n oː n ə x ([−fr] linked to n and oː)				*	*	*
c. [LEN]+ Nʲ ɛ ʂˠ tˠ ([+fr] linked to Nʲ and ɛ, [−fr] linked to ʂˠ tˠ)	i. nʲ ɛ ʂˠ tˠ ([+fr] linked to nʲ and ɛ, [−fr] linked to ʂˠ tˠ)	*!	*				
	ii. nʲ a ʂˠ tˠ ([+fr] linked to nʲ, [−fr] linked to a, ʂˠ tˠ)	*!			*	*	
	iii. n ɛ ʂˠ tˠ ([−fr] linked to n, [+fr] linked to ɛ, [−fr] linked to ʂˠ tˠ)		*!		*		*
	☞ iv. n a ʂˠ tˠ ([−fr] linked to n, a, ʂˠ tˠ)				**	**	*

Finally, if [Nʲ] is followed by a slender vowel that is in turn followed by an ABS trigger in the word-level input, as in input (c) for *neart* [naʂˠtˠ] 'strength' (lenited), the maximally faithful candidate (c-i) violates not only *[nʲ] but also high-ranked ABS. Spreading [−front] from the ABS trigger onto the preceding vowel (c-ii) would still incur a violation of the former, while epenthesising [−front] on the nasal (c-iii) would still incur a violation of the latter. [−front] therefore spreads from the ABS trigger onto both the preceding vowel and the initial nasal (c-iv) at the expense of low-ranked DEPLINK[−fr], MAXLINK[+fr] and MAX[+fr].

As mentioned in §5.4.1, there is insufficient data to determine what happens to exceptional items in which radical /Nʲ ʃNʲ/ is followed by an unforced broad vowel. The only such form in the data set is *neoichiontach* [NʲaxʲuN̥t̪əx] 'innocent', for which no lenited form is cited. If MAX[+fr] is ranked above both DEPLINK[+fr] and MAXLINK[−fr], then [+front] and [−front] will metathesise under lenition, yielding the lenited form *[nɛxʲuN̥t̪əx]; otherwise the lenited form will be *[naxʲuN̥t̪əx].

5.5.4 Phrase level: Slenderness neutralisation and front glide epenthesis

Because SN and FGE may be bled by the insertion of a prothetic consonant belonging to a preceding particle, they must be phrase-level processes. It is well-known that palatalised labial consonants are typologically marked relative to palatalised coronal or dorsal consonants (Stang 1957: 29; Chen 1973; Hock 1986: 74–75, 2006; Bateman 2007; 2011). In other words, no language will display palatalisation of labials if it does not also display palatalisation of coronals and dorsals. As noted by Hock (1986: 74–75) and Bateman (2007: 206–207), the greater amenability of coronals and dorsals to palatalisation probably arises from the fact that they are both produced using some part of the tongue as primary articulator, i.e. they are *lingual* consonants, while labials do not involve the tongue at all. Since palatalisation requires raising of the tongue body, there is a close articulatory interdependence between palatalisation and coronal or dorsal primary articulation.

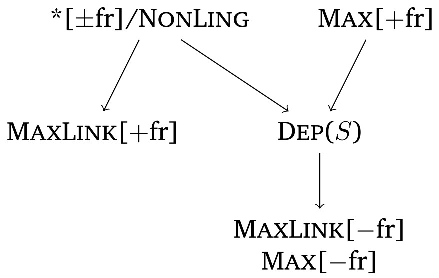
Hock (2006) specifically argues for a constraint that targets palatalised labial consonants. However, if the aforementioned articulatory grounding for the relative markedness of palatalised labials is correct, then we expect it to apply more generally to lingual secondary articulations not only in labials but in *all* consonants with non-lingual primary articulation, including those with no oral articulation. I therefore define the following markedness constraint, which targets all non-lingual consonants bearing slenderness features:

(27) *[±fr]/NONLING: Let C be a consonant in the output. Assign a violation mark if C is neither [CORONAL] nor [DORSAL] *and* C is [±front].

This constraint disfavours any slenderness specification on labial consonants as well as on placeless /h/ and /X/.

The observed patterns allow us to establish the phrase-level ranking in (28), as shown in the tableau in (29). Here I use the notation $C^{\emptyset}$ to explicitly represent a consonant that is neutral, i.e. unspecified for [±front], while plain C represents a broad consonant, i.e. one that is [−front]. In all cases, high-ranked *[±fr]/NONLING ensures that a non-lingual consonant becomes neutral. First of all, if the consonant shares [±front] with the following vowel in the phrase-level input, as in input (a) for

(28) Phrase level



baile [palʲə] ‘town’ and input (b) for *bean* [pʲɛn] ‘wife’, the fully faithful candidates (a-i,b-i) violate high-ranked *[±fr]/NONLING. [±front] is therefore delinked from the consonant (a-ii,b-ii) at the expense of low-ranked MAXLINK[−fr] or MAXLINK[+fr].

If the consonant is [+front] in the phrase-level input and the following vowel is [−front] by virtue of being rounded, as in input (c) for *beò* [pʲɔː] ‘alive’, the fully faithful candidate (c-i) again violates high-ranked *[±fr]/NONLING. However, outright deletion of [+front] from the consonant (c-ii) would incur a violation of high-ranked MAX[+fr], so a front glide is epenthesised (c-iii) at the expense of low-ranked MAXLINK[+fr] and DEP(S).

Finally, if the consonant is [−front] in the phrase-level input and the following vowel is [+front], as in input (d) for *faic* [fehkʲ] ‘see’, the fully faithful candidate (d-i) violates high-ranked *[±fr]/NONLING as before. This results in outright deletion of [−front] (d-ii) at the expense of low-ranked MAXLINK[−fr] and MAX[−fr]. Meanwhile, higher-ranked MAX[+fr] and DEP(S) rule out repairs in which MAX[−fr] is satisfied by transferring [−front] onto the vowel (d-iii) or epenthesising some kind of back glide (d-iv).

Omitted from the tableau in (29) are forms in which the consonant is [+front] in the phrase-level input and the following vowel is [−front] either due to ABS, e.g. *beart* [pɛ̯aʂˠʈˠ] ‘mill’, or because it is exceptionally specified as [−front], e.g. *beachd* [pɛ̯axk] ‘opinion’. This is because it is not possible to determine which constraints are responsible for the observed patterns with respect to these forms – specifically, for the fact that preservation of underlying [+front] is achieved through FGE rather than by making the vowel slender. Taking first the phrase-level input [pʲaʂˠʈˠ] ‘mill’, which yields the the output [p$^{\emptyset}$ɛ̯aʂˠʈˠ], one possible scenario is that either MAXLINK[−fr] or DEPLINK[+fr] (or both) is ranked above DEP(S) – in other words, phrase-level faith-

(29) Phrase level

Input		Candidate	*[±fr]/NonLing	Max[+fr]	MaxLink[+fr]	Dep(*S*)	MaxLink[−fr]	Max[−fr]
a. p a lʲ ə [−fr]		i. p a lʲ ə [−fr]	*!					
	☞	ii. p$^{\emptyset}$ a lʲ ə [−fr]					*	
b. pʲ ɛ n [+fr]		i. pʲ ɛ n [+fr]	*!					
	☞	ii. p$^{\emptyset}$ ɛ n [+fr]			*			
c. pʲ ɔː [+fr] [−fr]		i. pʲ ɔː [+fr] [−fr]	*!					
		ii. p$^{\emptyset}$ ɔː [−fr]		*!	*			
	☞	iii. p$^{\emptyset}$ e̯ ɔː [+fr] [−fr]			*	*		
d. f eʰkʲ [−fr] [+fr]		i. f eʰkʲ [−fr] [+fr]	*!					
	☞	ii. f$^{\emptyset}$ eʰkʲ [+fr]					*	*
		iii. f$^{\emptyset}$ ɤʰkʲ [−fr]		*!	*		*	
		iv. f$^{\emptyset}$ ɤ̯ eʰkʲ [−fr] [+fr]				*!		

fulness preserves the broad vowel quality that was enforced by ABS at the word level. Another possible scenario is that ABS itself remains high-ranked at the phrase level (with some prosodic restrictions that prevent it from occurring across word boundaries). Under either scenario, FGE will be preferred over making the vowel slender for the input [pʲas̪ˠt̪ˠ].

The former scenario predicts that the phrase-level input [pʲaxk] will yield the output [p$^{\emptyset}$e̯axk], and also that the lenited form of *teine* [t̪ʲʰanə] 'fire' will yield the output *theine* [h$^{\emptyset}$e̯anə], since it is faithfulness rather than ABS that preserves the broad quality of the vowel. On the other hand, the latter scenario predicts that the outputs will instead be [p$^{\emptyset}$ɛxk] and [h$^{\emptyset}$ɛnə], since ABS pays no role these forms. The variation in the available data suggests that both rankings may exist in competition with one

(30)		*dath* 'colour'	*leth* 'half'	*guth* 'voice'	*seo* 'this'	*dè* 'what'	*teine* 'fire'	*ceannach* 'buy.VN'
	UR	t̪A	Lʲ E	kU	ʃƆ	t̪eː	tʲʰanə	kʲʰANəx
		↓	↓	↓	↓	↓	↓	↓
	SL	t̪a	Lʲe	ku	ʃɔ	t̪eː	tʲʰanə	kʲʰɛNəx
		↓	↓	↓	↓	↓	↓	↓
	WL	t̪a	Lʲe	ku	ʃɔ	t̪eː	tʲʰanə	kʲʰaNəx
		↓	↓	↓	↓	↓	↓	↓
	PL	t̪a	Lʲe	ku	ʃɔ	t̪eː	tʲʰanə	kʲʰaNəx

another: recall from §5.4.4 that *bheachd*, the lenited form of *beachd*, is cited as both [ve̯axk] and [vɛxk], while *biorsamaid* 'spring balance' is cited as both [pi̯ɯʂˠəmatʲ] and [piʂˠəmatʲ]; recall also from §5.4.3 that *theine* is cited as both [he̯anə] and [hɛnə]. Oftedal does not specify whether this variation occurs between or within speakers, so it is not clear whether these two scenarios simply represent differing grammars between different speakers or a degree of stochasticity within individual speakers' rankings (*see* Boersma & Hayes 2001).

5.5.5 Summary of derivations

As an aid to the reader, the full stratal derivations of all relevant form types are summarised in (30)–(35). Note that, for the purposes of this section, I remain agnostic as to the stage in the derivation at which certain irrelevant processes occur, such as pre-aspiration or the formation of retroflex consonants, and include the outcomes of these in underlying forms for simplicity. Any suffixes or slenderisation are also included in underlying forms, since those aspects of the derivation are not relevant here. First of all, forms with an initial broad or slender consonant that remains unchanged throughout the derivation are shown in (30). In regular forms the vowel is underlyingly unspecified for slenderness; if the vowel is unrounded it becomes either broad or slender at the stem level according to SA, while if it is rounded it becomes broad regardless of the slenderness of the preceding consonant. However, in exceptional forms the vowel is already marked as either broad or slender in the underlying form and remains unchanged. This was illustrated in the tableau in (20). If a slender open vowel is followed by an ABS trigger, it becomes broad at the word level as illustrated in the tableau in (23).

(31)

	nigh 'wash.PST'	*neònach* 'strange' (lenited)	*neart* 'strength' (lenited)
UR	[LEN]+NʲI	[LEN]+NʲOːnəx	[LEN]+NʲAs̪ˠt̪ˠ
	↓	↓	↓
SL	[LEN]+Nʲi	[LEN]+Nʲoːnəx	[LEN]+Nʲɛs̪ˠt̪ˠ
	↓	↓	↓
WL	ni	noːnəx	nas̪ˠt̪ˠ
	↓	↓	↓
PL	ni	noːnəx	nas̪ˠt̪ˠ

(32)

	baile 'town'	*bean* 'wife'	*beò* 'alive'	*beart* 'loom'	*faic* 'see'
UR	pALʲə	pʲAn	pʲƆː	pʲAs̪ˠt̪ˠ	feʰkʲ
	↓	↓	↓	↓	↓
SL	paLʲə	pʲɛn	pʲɔː	pʲɛs̪ˠt̪ˠ	feʰkʲ
	↓	↓	↓	↓	↓
WL	paLʲə	pʲɛn	pʲɔː	pʲas̪ˠt̪ˠ	feʰkʲ
	↓	↓	↓	↓	↓
PL	p$^{\varnothing}$aLʲə	p$^{\varnothing}$ɛn	p$^{\varnothing}$ɛ̯ɔː	p$^{\varnothing}$ɛ̯as̪ˠt̪ˠ	f$^{\varnothing}$eʰkʲ

Secondly, forms with initial underlying slender /Nʲ/ that undergoes lenition to broad [n] are shown in (31). The stem-level derivation is exactly as before. The appropriate allomorph of the lenition prefix [LEN] then docks to initial /Nʲ/ at the word level, yielding broad [n], but the following vowel remains unchanged except in those cases where ABS occurs. This was illustrated in the tableau in (26). The same derivation will also apply to forms with initial underlying slender /ʃNʲ/ that undergoes lenition to [n], as well as, *mutatis mutandis*, those with initial underlying slender /ʃNʲ/ that undergoes *t*-substituion to [t̪ʰr].

Next, forms with an initial labial consonant are shown in (32). The stem- and word-level derivation is exactly as in (30). SN then occurs at the phrase level, and is accompanied by FGE in those cases where the consonant is underlyingly slender and the following vowel is broad, as illustrated in the tableau in (29). The same derivation applies to all labials as well as to forms with initial underlying /X⁽ʲ⁾/.

Forms with an initial broad /t̪ʰ s/ or slender /tʲʰ ʃ/ that undergoes lenition to neutral [h] are shown in (33). Again, the stem-level derivation is exactly as before. The appropriate allomorph of [LEN] then docks to the initial consonant at the word

(33)

	shad ‘throw.PST’	*sheasamh* ‘stand.VN’ (lenited)	*thionndaidh* ‘turn.PST’	*shealladh* ‘look.VN’ (lenited)
UR	[LEN]+sAt̪	[LEN]+ʃAsu	[LEN]+t^{jh}ƆUN̥t̪aj	[LEN]+ʃALəɣ
	↓	↓	↓	↓
SL	[LEN]+sat̪	[LEN]+ʃɛsu	[LEN]+t^{jh}ɔuN̥t̪aj	[LEN]+ʃɛLəɣ
	↓	↓	↓	↓
WL	hat̪	h^{j}ɛsu	h^{j}ɔuN̥t̪aj	h^{j}aLəɣ
	↓	↓	↓	↓
PL	h$^{\emptyset}$at̪	h$^{\emptyset}$ɛsu	h$^{\emptyset}$ɛ̯ɔuN̥t̪aj	h$^{\emptyset}$ɛ̯aLəɣ

(34)

	-n ad ‘hat’ (*n*-prothesis)	*-n each* ‘horse’ (*n*-prothesis)	*dh’ionnsaich* ‘learn’ (*dh*-prothesis)	*-n eallach* ‘load’ (*n*-prothesis)
UR	(Nt̪$^{\emptyset}$)#XAt̪	(Nt̪$^{\emptyset}$)#X^{j}Ax	(ɣ$^{\emptyset}$)#X^{j}ƆUsix^{j}	(Nt̪$^{\emptyset}$)#X^{j}ALəx
	↓	↓	↓	↓
SL	(Nt̪$^{\emptyset}$)#Xat̪	(Nt̪$^{\emptyset}$)#X^{j}ɛx	(ɣ$^{\emptyset}$)#X^{j}ɔusix^{j}	(Nt̪$^{\emptyset}$)#X^{j}ɛLəx
	↓	↓	↓	↓
WL	(Nt̪$^{\emptyset}$)#Xat̪	(Nt̪$^{\emptyset}$)#X^{j}ɛx	(ɣ$^{\emptyset}$)#X^{j}ɔusix^{j}	(Nt̪$^{\emptyset}$)#X^{j}aLəx
	↓	↓	↓	↓
PL	N$^{d̪}$at̪	N^{dj}ɛx	jɔusix^{j}	N^{dj}aLəx

	-g aiteamh ‘thaw.VN’ (*g*-prothesis)
UR	(k$^{\emptyset}$)#Xɛ^{h}t^{j}u
	↓
SL	(k$^{\emptyset}$)#Xɛ^{h}t^{j}u
	↓
WL	(k$^{\emptyset}$)#Xɛ^{h}t^{j}u
	↓
PL	kɛ^{h}t^{j}u

level, yielding either broad [h] or slender [h^{j}], and the following vowel again remains unchanged except in those cases where ABS occurs. The phrase-level derivation then proceeds exactly as for the labial consonants in (32).

Forms with an initial /X$^{(j)}$/ that undergoes coalescence with a prothetic coronal or dorsal consonant are shown in (34). The stem- and word-level derivation is exactly as in (30) and (32). The floating prothetic consonant or cluster, which is underlyingly unspecified for slenderness, then coalesces with /X$^{(j)}$/ at the phrase level and takes on its underlying slenderness value.

(35)

	-n fhasgaidh 'shelter.GEN' (*n*-prothesis)	*-n fhear* 'man' (*n*-prothesis)	*-n fheòil* 'meat' (*n*-prothesis)
UR	(Nt̪$^{\varnothing}$)#[LEN]+fAskaj	(Nt̪$^{\varnothing}$)#[LEN]+f^{j}Ar	(Nt̪$^{\varnothing}$)#[LEN]+f^{j}Ɔ:l^{j}
	↓	↓	↓
SL	(Nt̪$^{\varnothing}$)#[LEN]+faskaj	(Nt̪$^{\varnothing}$)#[LEN]+f^{j}ɛr	(Nt̪$^{\varnothing}$)#[LEN]+f^{j}ɔ:l^{j}
	↓	↓	↓
WL	(Nt̪$^{\varnothing}$)#Xaskaj	(Nt̪$^{\varnothing}$)#X^{j}ɛr	(Nt̪$^{\varnothing}$)#X^{j}ɔ:l^{j}
	↓	↓	↓
PL	N$^{d̪}$askaj	N^{dj}ɛr	N^{dj}ɔ:l^{j}

	-n fheannag 'lazybed' (*n*-prothesis)	*-n fhaic* 'see' (*n*-prothesis)
UR	(Nt̪$^{\varnothing}$)#[LEN]+f^{j}ANak	(Nt̪$^{\varnothing}$)#[LEN]+fe^{h}k^{j}
	↓	↓
SL	(Nt̪$^{\varnothing}$)#[LEN]+f^{j}ɛNak	(Nt̪$^{\varnothing}$)#[LEN]+fe^{h}k^{j}
	↓	↓
WL	(Nt̪$^{\varnothing}$)#X^{j}aNak	(Nt̪$^{\varnothing}$)#Xe^{h}k^{j}
	↓	↓
PL	N^{dj}aNak	N$^{d̪}$e^{h}k^{j}

Finally, forms with an initial /f^{j}/ that undergoes lenition to [X$^{(j)}$], followed by coalescence with a prothetic coronal or dorsal consonant, are shown in (35). Yet again, the stem-level derivation is exactly as before. The appropriate allomorph of [LEN] then docks to the initial consonant at the word level, yielding either broad [X] or slender [X^{j}], and ABS occurs where applicable. The phrase-level derivation then proceeds exactly as in (34).

5.6 Discussion

According to the token count in §5.4.6 there are 193 exceptional forms in the entire data set, making up 5.9% of the total number of forms cited by Oftedal (1956). These are items in which, according to the analysis presented, the stressed vowel must bear an underlying slenderness specification independent of the slenderness of the initial consonant or cluster. However, it is possible that the true number is in fact lower. First of all, around 35 of these forms are more or less transparent English or Scots loans, which may not have fully assimilated to the Scottish Gaelic phonological system.

Indeed, to take some of the most obvious cases, it is highly doubtful that forms such as [lʲɤkʃəri] 'luxury', [pʰlʲast̪ər] 'plaster', [siks] 'six' should be regarded as anything more than examples of code-switching to Lewis-accented English. If these items are not to be taken as counterexamples to generalisations about Scottish Gaelic phonology, then we can reduce the number of exceptional forms in the data set.

Of the remaining exceptions, 25 involve slender [ɛ(ː)] preceded by a broad consonant and followed by a labial consonant, /h/, or hiatus, e.g. *sàibh* [sɛːv] 'saw.GEN', *caitheamh* [kʰɛhu] 'spend.VN', *saighead* [sɛ.ət̪] 'arrow'. If, as in ch. 4, it is assumed that the underspecified consonant [X] is present not only in word-initial "empty" onsets but also in hiatus, then we can make the generalisation that [ɛ(ː)] is followed by a neutral consonant in these 25 forms. Since it has been established that the broad–slender contrast is underlyingly present in neutral consonants, it is possible that the slender quality of the vowel in these forms actually reflects underlying slender quality in the following consonant, which might be faithfully preserved by spreading onto a preceding open vowel whenever it cannot be realised on the consonant itself. This is supported by alternations like *sàbh* [saːv] 'saw', genitive *sàibh* [sɛːv], in which the stem-final consonant is neutral and genitive case is marked by making the vowel slender – forms of the same declensional class that end in a broad consonant, e.g. *bàs* [paːs] 'death', genitive *bàis* [paːʃ], undergo straightforward slenderisation of the stem-final consonant instead. However, due to the somewhat speculative nature of this rule, and the apparent inconsistency in outcome when we consider the form *làmh* [Laːv] 'hand', genitive *làimh* [Laiv] (not *[Lɛːv]), it has not been incorporated into the main analysis.

A further 22 of the exceptional forms involve a slender consonant followed by a broad vowel in a svarabhakti group (a stressed VCV sequence that is phonologically monosyllabic; *see* ch. 4). It is clear that there is at least a tendency for broad vowels to occur in such sequences in violation of SA, and this appears to be an absolute rule when the svarabhakti group consists of two open vowels separated by [r], e.g. *dearg* [tʲarak] 'red'. In other cases, however, any rule that might systematically determine the slenderness of the vowel appears to be too complex to confidently identify on the basis of the available data.[23]

[23]Recall from footnote 21 that [ɯ] transcribed by Oftedal in svarabhakti groups may actually be phonologically slender [i]. This would apply not just to *earball* [ɯrɯpəL] 'tail' but also to forms such as *tiomnadh* [tʲʰɯmɯnəɣ] 'testament'.

If transparent English or Scots loans are excluded, and these more speculative rules taken into account, the number of exceptional forms can potentially be reduced to around 115. This suggests that, once the correct underlying representations have been established on the basis of the patterns discussed in this paper, an efficient learner could get away with marking vowel slenderness in as few as 3.5% of all items in lexical storage. In the overwhelming majority of items, slenderness is either determined by the roundedness of the vowel or spreads from adjacent consonants by default.

It remains to be determined exactly to what degree this analysis may be applicable to other dialects of Scottish Gaelic. Extending it to the Ness system requires a slight modification of the triggering environment for ABS, taking in /x/ in addition to the velarised consonants, but would be simplified somewhat by a number of neutralisations of vowel contrasts reported in ch. 2.[24] As for Bernera, the analysis would require an additional process of *anticipatory slenderness spreading* that spreads slender quality from a slender consonant onto an immediately-preceding short low vowel under many circumstances, e.g. Bernera *cailleach* [kʰɛLʲəx] 'old woman' vs. Leurbost or Ness [kʰaLʲəx]. Venturing outwith Lewis, this process becomes more important as we head south towards Barra, while ABS gradually retreats to become a minor rule operating only before /N/ (*see* §5.5.1).

5.7 Conclusion

This paper has shown that the broad–slender contrast in Scottish Gaelic consonants occurs underlyingly not only in overtly broad or slender consonants, i.e. coronals or dorsals, but in neutral consonants, i.e. labials and /h/, as well. The analysis of neutral consonants is in turn extended to vowel-initial words, for which an underspecified initial consonant is posited similar to that which has been proposed for Irish. This means that, given the correct underlying representations, the slenderness of a vowel need not be marked underlyingly in the overwhelming majority of forms. A count of all of the Lewis Gaelic word-forms explicitly cited by Oftedal (1956) shows that lexically

[24] An analysis specific to Ness Gaelic would also have to account for the curious fact that [ɪ], the lax allophone of /i/ (*see* ch. 2), behaves as phonologically broad with respect to FGE if and only if it is followed by /ɣ/, e.g. *fiodh* [fjɪɣ] 'wood', *iodh* [jɪɣ] 'corn', *theanga* [xʲĩɣə], lenited form of *teanga* [tʲʰĩɣə] 'tongue' (where [xʲ] is the regular outcome of FGE in connection with [h] in Ness). This may indicate that retraction of /i/ occurs earlier in the derivation in this environment than in others.

marked exceptions make up at most 5.9% of the lexicon, and possibly as little as 3.5% once transparent loans are excluded and a handful of more speculative phonological rules are taken into account.

The complex opaque interactions that exist between slenderness and various phonological or morphological processes are successfully accounted for using the framework of Stratal OT. By assigning rules to phonological strata on the basis of their sensitivity to morphosyntactic boundaries, this paper has demonstrated the way in which Stratal OT is able to model highly complex phonological derivations in a principled manner without having to resort to empirically unrestrictive tools such as arbitrary rule ordering. Finally, the analysis presented here provides a fresh take on the phonological system of Scottish Gaelic as a whole, by showing that the well-known contrast between front and back unrounded vowels is in fact highly marginal at the level or lexical representation.

Chapter 6

Discussion

Each of the four main chapters of this thesis investigates a particular aspect of the sound system of Scottish Gaelic, and explores how the patterns observed can inform us about modularity and stratification in phonology. The interface between phonetics and phonology is investigated in chh. 2 and 3, where different types of categoricity are employed as diagnostic criteria in order to tease apart phonetic and phonological patterns in instrumental data. In ch. 2 I search for *distributional* categoricity in patterns of vowel allophony and show that speakers vary with respect to whether certain allophonic oppositions are phonetic or phonological. In ch. 3 I identify both phonetic and phonological processes of vowel nasalisation operating within the grammar on the basis of *dynamic* categoricity, and show that the results are fully consistent with a modular feedforward architecture of grammar in which no direct interface exists between morphology and phonetics. Meanwhile, in chh. 4 and 5 I provide highly detailed analyses of two different aspects of Scottish Gaelic phonology, finding that the framework of Stratal OT is able to account for the data in a principled manner.

A important direction for future research is the analysis of initial mutation in Scottish Gaelic, which would have implications for the Celtic languages more generally. As discussed in ch. 1, §1.1, an important prediction of the modular feedforward architecture employed in this thesis is the Morph Integrity Hypothesis (Bermúdez-Otero 2012: 50), from which it follows that all morphological processes are concatenative in nature. I assume this to be true throughout this thesis, but far more work is required on the autosegmental content of the morpheme that triggers initial mutation. The debuccalisation of /t̪^{h} t^{jh} s ʃ/ to [h] and deletion of /f$^{(j)}$/ (strictly, replacement of /f$^{(j)}$/ by

/X$^{(j)}$/) under lenition are particularly problematic for an additive account, although possible solutions for seemingly subtractive morphological processes are offered by Bye & Svenonius (2012: §10) and Iosad (2014: §3.2.1; 2017: §4.2.6).

This chapter picks up some points of general discussion that either draw upon additional data not discussed in the individual research papers, or bring together elements of more than one of the analyses presented in this thesis. §6.1 explores the opposition between phonetic and phonological sound patterns in Scottish Gaelic from a broader perspective than chh. 2 and 3, by showing how various examples of cross-dialectal variation can be explained as variation between phonetic and phonological manifestations of the same process. §6.2 discusses the use of abstract phonological structure in the analyses presented in chh. 4 and 5, particularly the occurrence of *absolutely neutralised* segments, and shows how the representations employed are motivated by several converging pieces of evidence in every case.

6.1 Phonetic and phonological sound patterns in Scottish Gaelic dialects

One of the most prominent recurring themes in the papers contained within this thesis is the distinction between phonetic sound patterns, which are gradient in nature, and phonological ones, which are categorical. Chh. 2 and 3 explore two different methods for distinguishing between gradient and categorical sound patterns in instrumental data. It is often also possible to identify phonetic and phonological manifestations of a single sound pattern when comparing descriptions of different dialects of Scottish Gaelic, and perhaps even descriptions of the same dialect at different points in time. This variation can be interpreted in terms of the *life cycle* of phonological processes (Bermúdez-Otero 2007; 2011: §3; 2015; Bermúdez-Otero & Trousdale 2012: §2; Turton 2014; Ramsammy 2015), whereby a sound pattern that is restricted to the gradient phonetics in conservative varieties may have undergone *stabilisation*, and thus belong to the categorical phonology, in more progressive varieties. First of all, a distinction is made in ch. 4 between northern dialects, such as Lewis, in which a stressed vowel undergoes lengthening before an underlyingly fortis coda sonorant, e.g. *call* [k^{h}auL] 'lose.VN', and some Argyll dialects in the extreme southwest, such as Islay, in which the sonorant is geminated instead, e.g. [k^haL:]. This is interpreted as phonological variation between dialects with and without a categorical process that transfers a mora (itself the product of stem-level WBP) from the sonorant onto the vowel. However, Jones (2010: 61 ff.) notes for Jura – which is geographically somewhat intermediate between the two areas – that the vowel and the sonorant are actually both half-long phonetically in forms of this type, e.g. [k^haˑLˑ]. Since a rhyme of this type in Jura contrasts with a long vowel + a singleton sonorant (e.g. *càl* [k^ha:L] 'cabbage'), but not with a short vowel + a geminate sonorant (*[k^haL:]), it is clear that the length in [k^haˑLˑ] belongs to the sonorant rather than the vowel at the phonological level. This form therefore displays a phonologically geminate sonorant which transfers part of its duration onto the preceding vowel. Since the duration transferred is equivalent to less than one mora, this process must belong to the gradient phonetics rather than the categorical phonology. We can therefore identify a typology of three dialect types, exemplified by (i) Islay, which has no duration transfer process at all, (ii) Jura, which has a gradient phonetic duration transfer process, and (iii) Lewis, which has a categorical phonological mora transfer process:

(1)		**Islay**	**Jura**	**Lewis**
	Underlying form:	/k^haL/	/k^haL/	/k^haL/
	Stem-level WBP:	[k^haL:]	[k^haL:]	[k^haL:]
	Word-level mora transfer:	[k^haL:]	[k^haL:]	[k^hauL]
	Phonetic duration transfer:	[k^haL:]	[k^haˑLˑ]	[k^hauL]

Islay, in the extreme southwest geographically, is the most conservative dialect type diachronically. Jura, slightly to the north, differs from Islay in having innovated a duration transfer process in the phonetics. Beyond Jura, in more progressive northern dialects such as Lewis, this process has advanced a step further on this diachronic trajectory and undergone stabilisation to become a categorical mora transfer process.[1]

[1] Jones (2010: 62) speculates that the Jura forms might represent a direct reflex of the *síneadh meadhónach* ("middle quantity") evidenced by Early Irish poetic metre (*see* e.g. Greene 1952). This interpretation rests on the assumption that *síneadh meadhónach* in Early Irish referred to an intermediate degree of vowel length like that observed in present-day Jura Gaelic. In accordance with Greene (1952), however, I believe that *síneadh meadhónach* implied no lengthening of the vowel, since it also applied to forms that now display svarabhakti rather than lengthening, but rather described a syllable with a short (monomoraic) vowel and a heavy (moraic) coda. These syllables were distinguished from ordinary short syllables, containing a short (monomoraic) vowel and at most a light (non-moraic) coda, and ordinary long syllables, containing at least a long (dimoraic) vowel or diphthong.

Additionally, a distinction is made in ch. 4 between the vast majority of dialects, which display svarabhakti, e.g. Lewis *dorcha* [t̪ɔrɔx] 'dark', and the dialect of East Perthshire described by Ó Murchú (1989), in which svarabhakti does not occur, e.g. [t̪ɔrːx]. However, Ó Murchú (1989: 92 ff.) notes that, even in East Perthshire, a very short "vocalic release" may intervene in clusters of the relevant type. Although this interval is obligatory in some clusters, it is optional in others, and when it does occur it falls short of a full vowel. It therefore must be analysed as belonging to the gradient phonetics rather than the categorical phonology. In diachronic terms, it can be regarded as the gradient phonetic precursor to the fully segmental svarabhakti vowel that has developed in more progressive dialects. Note that the system described by Ó Murchú (1989), which is primarily based on a single speaker, appears to have been largely displaced in East Perthshire by a system with full svarabhakti like that found in other dialects. While an early description by Robertson (1900: 23) also notes the absence of full svarabhakti vowels in this dialect, forms without svarabhakti vowels are only sporadically recorded in *SGDS* for East Perthshire speakers (mostly pts. 190 and 195, e.g. *ainm*), and very occasionally for a few other far-eastern mainland speakers. Svarabhakti therefore seems to have recently begun undergoing stabilisation in East Perthshire.[2]

Iosad (to appear) provides a detailed analysis of dialectal variation in the realisation of pre-aspiration in Scottish Gaelic, and shows that the observed patterns are well-suited to an interpretation in terms of the life cycle of phonological processes. He argues that the short glottal preaspiration found in Lewis results from gestural timing effects at the phonetic level, and was once found over the vast majority of Gaelic-speaking Scotland. Meanwhile, the fully segmental [h∼x] found in most other dialects is phonological and represents a more recent innovation. This is therefore another example of both phonetic and phonological manifestations of the same sound pattern occurring in different dialects of Scottish Gaelic: pre-aspiration is restricted to the phonetics in conservative dialects such as Lewis, but has undergone stabilisation in more progressive dialects.

[2]Although the conservative nature of traditional Scottish Gaelic orthography – which does not mark svarabhakti vowels – makes it difficult to date the appearance of svarabhakti historically, note also that svarabhakti vowels are not marked in the *Book of the Dean of Lismore*, a Scottish Gaelic manuscript compiled in East Perthshire in the 16th century and written in a Scots-based orthography free from the influence of traditional Scottish Gaelic spelling.

Finally, it is possible that stabilisation might be observable in real time in the Lewis Gaelic realisation of nasal + stop clusters that are word-initial or in the onset of a stressed syllable. As discussed in §1.2.1, early descriptions by Borgstrøm (1940) and Oftedal (1956) describe the outcome as a post-stopped nasal, even though it appears likely that only pure nasals occur in the present-day dialect. It is not necessarily clear that the partial coalescence that produces a post-stopped nasal should be regarded as phonetic rather than phonological, since a post-stopped nasal could theoretically be represented in the categorical phonology as a contour segment. However, both Borgstrøm (1940: 22) and Oftedal (1956: 100) allude to a degree of variability in the degree and perceptibility of post-stopping in these sounds, which suggests that this partial coalescence is phonetic. If this is correct, then the development of ordinary pure nasals in the present-day dialect would be yet another example of stabilisation.

6.2 Converging evidence for abstract phonological structure

Another recurring theme in this thesis is the use of relatively abstract phonological representations in order to maintain generalisations about the sound system of Scottish Gaelic. To give one example, the analyses presented in chh. 4 and 5 posit an underlying contrast between broad fortis /L/ and broad lenis /l/ in Lewis Gaelic, on the basis of the dual phonological behaviour of the surface segment [L]. This is in spite of the fact that these two underlying segments are *absolutely neutralised*, meaning that they are not distinguished on the surface in any environment.[3] Whether such a degree of abstraction should be permitted in phonological analyses is a subject of controversy (e.g. Kiparsky 1973; Hyman 1970; 1988; 2003; Baković 2009; Sandstedt 2020), and putative examples of absolute neutralisation are frequently subjected to intense scrutiny. For instance, Hantgan & Davis (2012) offer an analysis of tongue root harmony in Bondu-so in which close and open vowels, despite not displaying a tongue root contrast on the surface, are underlyingly specified for [±ATR] on the basis of their behaviour as harmony triggers. Sandstedt (2020) argues that this is incorrect, and offers an alternative analysis that does not require absolute neutralisation.

[3] N.B. *Absolute neutralisation*, as the term is used here, must not be confused with the separate concept of *complete* vs. *incomplete* neutralisation discussed in ch. 3.

Analyses involving absolute neutralisation are vulnerable to accusations of circularity due to the lack of independent evidence for the putative underlying contrast. This is because absolutely neutralised segments are typically posited exclusively on the basis of the dual behaviour of a surface segment with respect to one particular phonological process. Throughout this thesis, however, care has been taken to ensure that independent evidence for absolutely neutralised underlying segments comes from more than one aspect of their phonological behaviour. For instance, recall from ch. 4, §4.1.1 and ch. 5, §5.2.1 that broad fortis [L] displays dual behaviour with respect to slenderisation, alternating with slender fortis [Lʲ] in some items and slender lenis [lʲ] in others:

(2) a. [L] alternates with [Lʲ]

Dòmhnall	[t̪oː.əL]	'Donald'	GEN	*Dhòmhnaill*	[ɣoː.iLʲ]
peirceall	[pʰer̥ʲkʲəL]	'jaw'	PL	*peircill*	[pʰer̥ʲkʲiLʲ]

b. [L] alternates with [lʲ]

diabhal	[tʲiəvəL]	'devil'	GEN	*diabhail*	[tʲiəvəlʲ]
saoghal	[sɯːvəL]	'world'	GEN	*saoghail*	[sɯːvəlʲ]

I take this as evidence that [L] represents underlying broad fortis /L/ in the forms in (2a) and underlying broad lenis /l/ in those in (2b), even though the latter is merged with the former on the surface in all environments. Recall also from ch. 4, §4.4.1 that stem-final fortis sonorants generally trigger lengthening of an immediately-preceding tautosyllabic short stressed vowel, with the exception of [L], which displays dual behaviour in that it may or may not trigger lengthening. On the basis of the phonological behaviour of transparent fortis–lenis sonorant pairs in Scottish Gaelic, I assume that [L] represents underlying broad fortis /L/ when lengthening occurs, and broad lenis /l/ when it does not. There are therefore two independent strands of evidence for the existence of the same underlying contrast. Moreover, the two diagnostic criteria for the underlying status of [L] always agree in those cases where both are available, i.e. when [L] is stem-final and preceded by a stressed vowel. If [L] triggers lengthening then it alternates with slender fortis [Lʲ] under slenderisation, and if it does not trigger lengthening it alternates with slender lenis [lʲ]:

(3) a. [L] triggers lengthening and alternates with [L^{j}]

ball [pauL] 'limb' GEN *buill* [pɤiL^{j}]

toll [t̪^{h}ɔuL] 'hole' GEN *tuill* [t̪^{h}ɤiL^{j}]

b. [L] does not trigger lengthening and alternates with [l^{j}]

geal [k^{j}aL] 'white' CMP *gile* [k^{j}il^{j}-ə]

mol [mɔL] 'shingle' GEN *muile* [mul^{j}-ə]

Note that this analysis is structurally well-motivated, since broad lenis /l/ fills a prominent gap in the phonemic inventory of Scottish Gaelic and requires no additional featural specifications beyond those that are found elsewhere in the system of coronal sonorants. Additionally, when one or both of these criteria can be used to determine whether [L] is underlyingly fortis or lenis, the result is almost always in agreement with the cross-dialectal and historical facts. The forms *saoghal* and *geal* both appear in *SGDS*, and are transcribed with lenis [l] in the extreme west of Lewis and Harris (pts. 5 and 10), where the contrast is maintained on the surface. Meanwhile, the forms *ball* and *toll* also appear, and are transcribed with fortis [L] in those dialects. Historically, *saoghal* and *geal* reflect Early Irish *saegul* [saiɣul], *gel* [ɡ^{j}el] with lenis [l], while *ball* and *toll* reflect Early Irish *ball* [baL], *toll* [t̪oL] with fortis [L].

A similar structural gap in the system of coronal sonorants is filled by slender lenis /n^{j}/, which is merged with either broad lenis /n/ or slender fortis /N^{j}/ on the surface in all environments. Recall from ch. 5, §5.2 that lenition of initial slender fortis /N^{j}/ gives broad lenis [n], and slenderisation of stem-final broad lenis /n/ gives slender fortis [N^{j}]. In both cases, the expected outcome would be slender lenis *[n^{j}] on the basis of the phonological behaviour of other consonants. There is therefore strong evidence for a phonological process that repairs derived *[n^{j}], by making it broad in initial position and by making it fortis in non-initial position. As for the existence of /n^{j}/ in underlying forms, the slender quality of the following vowel in a non-alternating form such as *nì* [ni:] 'do.NPST' suggests that [n] is underlyingly slender, while the absence of lengthening in a form such as *muin* [muN^{j}] 'back' suggests that [N^{j}] is underlyingly lenis. There are therefore two independent pieces of evidence for the existence of underlying slender lenis /n^{j}/, while the phonological process that merges it with either /n/ or /N^{j}/ on the surface is already well-motivated on the basis of morphological alternations. As for the historical facts, the development of *nì* is not straightforward, but *muin* reflects Early Irish *muin* [mun^{j}] with lenis [n^{j}].

The third structural gap in the system of coronal sonorants would be filled by slender fortis */R^{j}/. However, the only potential piece of evidence for this segment in synchronic underlying forms is the quality of the following vowel in forms such as *rìgh* [Ri:] 'king'. Note that in this case, due to the lack of any additional independent evidence, I conclude in ch. 5, §5.4.2 that there is insufficient motivation for its existence.

Another example of absolute neutralisation is the contrast between /xk/ and /^{h}k/ proposed in ch. 4, §4.4.4 for dialects such as Barra, which is not realised on the surface in any environment. I assume that stem-final [xk] represents underlying /^{h}k/ in those items where it is capable of undergoing slenderisation to [x^{j}k^{j}], and underlying /xk/ in those where slenderisation is blocked. This contrast can be observed in the masculine genitive form of attributive adjectives, where both lenition and slenderisation occur whenever possible:

(4) **Barra** (Borgstrøm 1937)

	M.DIR		M.GEN		
a.	[xk] can undergo slenderisation				
	breac	[pr^{j}ɛxk]	*bhric*	[vr^{j}ix^{j}k^{j}]	'speckled'
b.	[xk] cannot undergo slenderisation				
	bochd	[pɔxk]	*bhochd*	[vɔxk]	'poor'

Recall also that clusters of a lenis sonorant + [xk] may fail to trigger svarabhakti in these dialects. I account for this by assuming that [xk] actually represents underlying /^{h}k/ in those cases, since this would block stem-level WBP on the sonorant and thus prevent svarabhakti from occurring. There are therefore, once again, two independent strands of evidence for the existence of this underlying contrast. As with [L], the two diagnostic criteria for the underlying status of [xk] always agree in those cases where both are available, i.e. when a cluster of a lenis sonorant + [xk] occurs stem-finally. In the following items, the cluster not only fails to trigger svarabhakti but also may undergo slenderisation:[4]

[4] I know of no examples of a stem-final cluster of a lenis sonorant + [xk] where either criterion points to underlying /xk/ rather than /^{h}k/.

(5) **Barra** (Borgstrøm 1937)

cearc [k^{jh}ɛrxk] 'hen' PREP *circ* [k^{jh}ir^{j}x^{j}k^{j}]

olc [ɔLxk] 'evil' GEN *uilc* [ul^{j}x^{j}k^{j}]

Note that this analysis is again structurally well-motivated, since the absence of pre-aspirated /^{h}k/ would result in a prominent gap in the phonemic inventory of these dialects. The resulting distribution of underlying /xk/ and /^{h}k/ again agrees with the cross-dialectal and historical facts: *breac*, *cearc* and *olc*, reflecting Early Irish *brecc* [b^{j}r^{j}ek], *cerc* [k^{j}erk], *olc* [olk] with a velar stop [k], have [^{h}k] in Lewis, where the contrast is maintained on the surface. On the other hand, *bochd*, reflecting Early Irish *bocht* [boxt̪] with a cluster [xt̪], has [xk] in Lewis.

Finally, another example of relatively abstract phonological structure proposed in this thesis is the underspecified consonant /X$^{(j)}$/, which I assume occupies all otherwise-empty onsets in Scottish Gaelic. This consonant is first proposed in ch. 4, §4.2.2 in order to ensure the correct syllabification of hiatus sequences. It is subsequently shown in §4.3.2 that the presence of this consonant in hiatus is able to explain several cases of apparent overapplication of svarabhakti. Independently of this, /X$^{(j)}$/ is also posited in ch. 5, §5.4.5 in word-initial position in order to account for the slenderness of word-initial vowels as well as the slenderness of prothetic consonants. Somewhat speculatively, it is also suggested in §5.6 that the presence of /X^{j}/ in hiatus might be able to explain a number of exceptional forms containing slender [ɛ(:)] where broad [a(:)] would otherwise be expected. There are therefore multiple independent strands of evidence for the existence of an abstract consonant of this type in phonological representations in Scottish Gaelic.

Chapter 7

Conclusion

The four research papers contained within this thesis discuss several different aspects of the sound system of Scottish Gaelic, and are tied together by the common theme of modularity and stratification in phonology. The distinction between phonetic and phonological sound patterns is explored in ch. 2, which investigates various patterns of vowel allophony in the Ness dialect of Scottish Gaelic, and in ch. 3, which investigates complex patterns of vowel nasalisation and their interaction with initial mutation. The data are shown to support a modular feedforward architecture of grammar in which there exists a clear separation between phonetics and phonology and only the latter has access to morphological information. Besides their theoretical contribution, these papers provide vital documentation of certain aspects of Scottish Gaelic phonology that have thus far escaped detailed instrumental investigation.

In chh. 4 and 5 I provide detailed Stratal OT analyses of the Class 1–Class 2 contrast and the broad–slender contrast respectively. As well as demonstrating the power of Stratal OT to account for the complex sound patterns observed in an internally consistent manner, often making use of independently motivated abstract phonological structure, these papers make a vital contribution to the study of Scottish Gaelic phonology by gathering together large quantities of data from primary sources in order to provide unprecedentedly detailed descriptive accounts of the phenomena in question. It is hoped that the data and analyses presented in this thesis will be of use to future researchers, even if they ultimately reach theoretical conclusions that differ from my own.

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Appendix A

Although most modern works, including this thesis, employ a version of the International Phonetic Alphabet, the following important points of variation and/or potential confusion should be carefully noted:

Consonants

- I transcribe palatalisation with following [ʲ], except for [ʃ] (*see also* coronal sonorants below); other sources may use a prime [′] or similar.
- I transcribe the two series of stops as aspirated (when initial) voiceless [pʰ t̪ʰ tʲʰ kʰ kʲʰ] vs. plain voiceless [p t̪ tʲ k kʲ], reflecting phonetic reality (Shuken 1980: ch. 5; Ladefoged et al. 1998; Nance & Stuart-Smith 2013); Other sources may use plain [p] vs. voiced [b] etc., or aspirated [pʰ] vs. devoiced [b̥] etc.
- I transcribe the broad coronal stops as explicitly denti-alveolar [t̪ʰ t̪]. Other sources may omit the dental diacritic.
- I transcribe the slender coronal stops as palatalised [tʲʰ tʲ], without affrication. They tend towards affricates [tʃʰ tʃ] in many varieties, and may be transcribed as such in other sources.
- I transcribe the slender dorsal consonants as [kʲʰ kʲ xʲ j]; the first three may be transcribed in other sources as pure palatals [cʰ c ç]. Other sources may transcribe the last sound as a fricative [ɣʲ] or [j̝], especially in initial position, while using [j] for the vocalic front glide that may precede a stressed broad vowel under certain circumstances (*see below*).
- Throughout this thesis I transcribe the coronal sonorants in an abstract notation using upper- and lower-case letters. When providing IPA transcriptions of the coronal sonorants in §1.2.1, I transcribe [n̪ˠ n ɲ] for abstract [N n Nʲ], [l̪ˠ ʎ lʲ] for abstract [L Lʲ lʲ], and [rˠ ɾ ðʲ] for abstract [R r rʲ].
  - For the velarised sounds [n̪ˠ l̪ˠ rˠ] (= abstract [N L R]), other sources may transcribe [n̴ ɫ r̴].
  - For palatal [ɲ ʎ] (= abstract [Nʲ Lʲ]), other sources may transcribe palatalised alveolar [nʲ lʲ] or palatalised dental [n̪ʲ l̪ʲ], reflecting the fact that they may display a degree of (denti-)alveolar contact.
  - For palatalised alveolar [lʲ] (= abstract [lʲ]), other sources may transcribe plain [l], reflecting the fact that palatalisation on this sound is usually very weak.
  - For the alveolar tap [ɾ] (= abstract [r]), other sources may transcribe ordinary [r].

– For the palatalised dental fricative [ðʲ] (= abstract [rʲ]), other sources may transcribe plain [ð], reflecting the fact that palatalisation on this sound is usually very weak.

- I transcribe velarised retroflex [ʈˠ ʂˠ ɳˠ ɭˠ] for what are normally assumed to represent underlying clusters of /R/ + coronal consonant in Lewis Gaelic, in agreement with Borgstrøm (1940: 75–76) and Oftedal's (1956: 126–127) descriptions. Other sources may omit the velarisation, or use [ɾʈ] etc. or similar.

Vowels

- For the unrounded non-front close-mid vowel [ɤ], other sources may use [ə].

- Only in chh. 2 and 3 do I transcribe the allophonic variation between tense [i] and lax [ɪ], and between unretracted [a ʉ] and retracted [ɑ u] (*see* ch. 2). To the extent that these oppositions exist outwith Ness, they are ignored in chh. 4 and 5, which are concerned with a deeper level of phonological representation. In these chapters I transcribe only [i a u].

- Only in chh. 2 and 3 do I transcribe nasalisation on vowels, and even then only when I believe it to be phonological (*see* ch. 3). For simplicity, nasalisation is ignored in chh. 4 and 5.

- In chh. 4 and 5 I transcribe [i̯ e̯ ɛ̯] for the height-harmonic front glide that may precede a stressed broad vowel under certain circumstances (*see* §§5.4.3–5.4.5); other sources may transcribe [j] (alongside a fricative transcription for my [j], *see above*) or [i̯] in all cases. In Bernera and Ness, however, this sound is merged with consonantal [j], so it is transcribed as such in chh. 2 and 3, which are concerned with Ness Gaelic specifically. In ch. 4, which draws forms from a variety of Lewis subdialects, I normalise to [i̯ e̯ ɛ̯] even when citing forms from Bernera or Ness.

  – When this front glide follows a labial consonant, other sources may transcribe it as palatalisation instead, e.g. [pʲʰ pʲ fʲ vʲ mʲ]. I employ this notation only at an abstract level of phonological representation (*see* ch. 5).

Prosody

- Stress should be assumed to occur on the initial syllable unless explicitly marked otherwise.

- Only in ch. 4 do I mark the tonal opposition that distinguishes Class 1 and Class 2 forms, with which that chapter is concerned. In other chapters, however, the Class 1–Class 2 opposition is indirectly marked, where applicable, by the presence (Class 1) or absence (Class 2) of hiatus.

- Likewise, only in ch. 4 do I mark the final devoicing that occurs in stressed monomoraic forms before pausa, specifically as [ʰ] after a final vowel or devoicing of a final voiced consonant (*see* §4.2.1). Other sources may transcribe segmental [h] in the former case.

- In ch. 4 I employ [ˀ] for glottalisation in Argyll Gaelic. Other sources may transcribe segmental [ʔ].

Appendix B

As an aid to the reader, the basic principles of Scottish Gaelic orthography are outlined here. While these rules account for the majority of forms, many exceptions and minor rules exist. *See* Bauer (2011) for a detailed treatment.

Consonants

- The orthographic representation of consonants is shown in Table B.1. All consonants, including neutral ones, are orthographically marked as either broad or slender. A consonant (or cluster) is marked as broad by preceding and/or following *a o u*, and as slender by preceding *i* and/or following *i e*; if the consonant/cluster is intervocalic, the preceding and following vowel graphs must agree in this respect. This is achieved through the complex system of vowel graphs shown in Tables B.2 and B.3.
- Slenderisation of a stem-final consonant is marked by changing the preceding vowel graph from one used before a broad consonant to the corresponding one used before a slender consonant.
- Initial mutation:
  - Lenition of *b c d f g m p s t* is marked by insertion of a following *h*. Lenition of *l n r* is not marked orthographically.
  - *T*-substitution is marked by prefixation of *t*-.
- Prothetic consonants:
  - *N*-prothesis is normally marked by final *n* (*m* before *b p*) on the triggering particle.
  - *Nt*-prothesis is marked by final *n* on the triggering particle and prefixation of *t*- on the target word.
  - *H*-prothesis is marked by prefixation of *h*- on the target word.
  - *Dh*-prothesis is marked by prefixation of *dh'* on the target word.
  - *G*-prothesis is marked by final *g* on the triggering particle.

Vowels

- The orthographic representations of stressed and unstressed vowels are shown in Tables B.2 and B.3 respectively. Different graphs are used according to whether the preceding or following consonants are to be marked as broad or slender (*see* Table B.1).

Table B.1: The orthographic representation of consonants

	Initial		Non-initial	
	Broad	**Slender**	**Broad**	**Slender**
b	[p]		[p]	
bh	[v]		[v Ø][a]	
c	[kʰ]	[kʲʰ]	[ʰk]	[ʰkʲ]
ch	[x]	[xʲ]	[x]	[xʲ]
chd	n/a		[xk]	[xʲkʲ]
d	[t̪]	[tʲ]	[t̪]	[tʲ]
dh	[ɣ]	[j]	[ɣ Ø][a]	[j Ø][a]
f	[f]		n/a	
fh	[Ø]		n/a	
g	[k]	[kʲ]	[k]	[kʲ]
gh	[ɣ]	[j]	[ɣ Ø][a]	[j Ø][a]
l	[L]	[Lʲ lʲ][b]	[L]	[lʲ]
ll	n/a		[L]	[Lʲ]
m	[m]		[m]	
mh	[v]		[v Ø][a]	
n	[N n][b]	[Nʲ n][b]	[n]	[Nʲ] [n][c]
nn	n/a		[N]	[Nʲ]
p	[pʰ]		[ʰp]	
ph	[f]		n/a	
r	[R r][b]		[r]	[rʲ]
rd	n/a		[ʈˠ]	
rl	n/a		[ɭˠ]	
rn	n/a		[ɳˠ]	
rr	n/a		[R]	
rs	n/a		[ʂˠ]	
rt	n/a		[ʂˠʈˠ]	
s	[s]	[ʃ]	[s]	[ʃ]
sh	[h]		n/a	
t	[t̪ʰ]	[tʲʰ]	[ʰt̪]	[ʰtʲ]
th	[h]		[h Ø][a]	

[a]Indicates hiatus when silent.
[b]Fortis in radical contexts and lenis in lenition contexts.
[c]After stressed *ei èi i ì* in Bernera and Ness.

- Vowels are normally nasalised when adjacent to orthographic *m mh n nn* (irrespective of how/whether this is pronounced).

Prosody

- Svarabhakti vowels are normally distinguished from ordinary unstressed vowels by not being marked at all in orthography.
- Hiatus is marked with silent *bh dh gh mh th* (*see* Table B.1).

Table B.2: The orthographic representation of stressed vowels

		Before broad C		Before slender C
After broad C	*a*	[a] [au][a]	*ai*	[a] [ai][a]
	à	[aː]	*ài*	[aː]
	ao	[ɯː]	*aoi*	[ɯː]
	o	[o ɔ] [ɔu][a]	*oi*	[o ɔ ɤ] [ɤi][a]
	ò	[oː ɔː]	*òi*	[oː ɔː]
	u	[u] [ɔu][a]	*ui*	[u ɯ] [ui ɤi][a]
	ua	[uə ua]	*uai*	[uə ua]
	ù	[uː]	*ùi*	[uː]
After slender C	*ea*	[e ɛ] [(ɛ̯)a][b,c] [(ɛ̯)au][c,d]	*ei*	[e ɛ] [ei][d]
	eà	[(ɛ̯)aː][c]		
	èa	[ia eː ɛː]	*èi*	[eː ɛː]
	eo	[(e̯)o (ɛ̯)ɔ][c]		
	eò	[(e̯)oː (ɛ̯)ɔː][c]	*eòi*	[(e̯)oː (ɛ̯)ɔː][c]
	eu	[ia eː ɛː]		
	ia	[iə]		
	io	[i] [(i̯)u][c,e] [(ɛ̯)ɔu][a,c]	*i*	[i] [ei][d]
	ìo	[iə iː]	*ì*	[iː]
	iu	[(i̯)u][c]		
	iù	[(i̯)uː][c]	*iùi*	[(i̯)uː][c]

[a]Before pre-consonantal or word-final *ll m nn*.
[b]Before *l rs rt* or pre-vocalic *ll nn rr*.
[c]The front glide occurs when word-initial or preceded by *b bh f fh m mh p ph sh th*.
[d]Before pre-consonantal or word-final *ll nn*.
[e]Before *l* or pre-vocalic *ll nn*.

Table B.3: The orthographic representation of unstressed vowels

	Before broad C		Before slender C		Word-final	
After broad C	*a*	[ə a]	*ai*	[ə i a]	*a*	[ə]
After slender C	*ea*	[ə a]	*i* *ei*	[ə i] [a]	*e*	[ə]

Appendix C

The 144 items used in the acoustic study of Ness Gaelic vowels reported in ch. 2, §2.3 is shown in Table C.1. Any relevant variant pronunciations by individual speakers are noted.

Table C.1: The 144 items used in the acoustic study in ch. 2

	/i/: Environment A		
bruich	[prixʲ]	‘boil’	
duine	[t̪iNʲə]	‘man’	
gille	[kʲiLʲə]	‘lad’	
miotag	[mĩʰt̪ak]	‘glove’	
nighean	[Nʲĩ.ən]	‘daughter’	
tric	[t̪ʰriʰkʲ]	‘often’	
tuig	[t̪ʰikʲ]	‘understand’	
tuilleadh	[t̪ʰiLʲəɣ]	‘more’	
uisge	[iʃkʲ]	‘rain’	
	/i/: Environment B		
bioran	[pɪran]	‘stick’	
fiodh	[fjɪɣ]	‘wood’	
fios	[fɪs]	‘knowledge’	
giomach	[kʲɪməx]	‘lobster’	
mil	[mĩlʲ]	‘honey’	
sil	[ʃɪlʲ]	‘drip’	Presented to S1,2,7 only
siud	[ʃɪt̪]	‘that’	Presented to S3,4,5,6,8,9 only
teanga	[tʲʰĩɣə]	‘tongue’	S2,3,6,7: /e/
	/e/: Environment A		
beatha	[pe]	‘life’	
breac	[prʲeʰk]	‘trout’	S4: /a/.
cait	[kʰeʰtʲ]	‘cat.PL’	
ceithir	[kʲʰehərʲ]	‘four’	
eathar	[ehər]	‘boat’	
faic	[fẽʰkʲ]	‘see’	
reic	[Reʰkʲ]	‘sell’	
soitheach	[se.əx]	‘vessel’	
	/e/: Environment B		
beag	[pɛk]	‘small’	
bean	[pɛn]	‘wife’	
deich	[tʲɛxʲ]	‘ten’	
eilean	[ɛlʲan]	‘island’	
freagairt	[frɛkət̪ˠ]	‘answer’	
geir	[kʲɛrʲ]	‘suet’	
nead	[Nʲɛ̃t̪]	‘nest’	
seas	[ʃɛs]	‘stand’	
	/a/: Non-retracting		
a-mach	[əˈmãx]	‘out’	
anam	[anəm]	‘soul’	

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aran	[aran]	‘bread’	
bac	[paʰk]	‘obstruct’	Presented to S1,2,7 only
Bac	[paʰk]	‘Back’	Presented to S3,4,5,6,8,9 only
broilleach	[praLʲəx]	‘chest’	
caidil	[kʰatʲəlʲ]	‘small’	
can	[kʲan]	‘say’	
caraid	[kʰarətʲ]	‘friend’	
cearc	[kʲʰar̥k]	‘hen’	
cearcall	[kʲʰar̥kəL]	‘circle’	
dad	[t̪at̪]	‘anything’	
dearcan	[tʲar̥kan]	‘burr’	
doras	[t̪arəs]	‘door’	
each	[jax]	‘horse’	
fada	[fat̪ə]	‘long’	
faigh	[fãj]	‘get’	
farpais	[far̥pəʃ]	‘competition’	
feamainn	[fjãmiNʲ]	‘seaweed’	S3,4,5,6,7,8: /e/
gach	[kax]	‘each’	
leabaidh	[Lʲapi]	‘bed’	
lean	[Lʲan]	‘follow’	S3,4,5,6,8,9: /e/
mac	[mãʰk]	‘son’	
marag	[marak]	‘pudding’	
math	[mã]	‘good’	
neach	[Nʲãx]	‘person’	
seac	[ʃaʰk]	‘wither’	S6: /e/
tac	[t̪ʰaʰk]	‘farm’	
teine	[tʲʰanə]	‘fire’	
		/a/: Before /N/	
ceannaich	[kʲʰɑNixʲ]	‘buy’	
fannaich	[fɑNixʲ]	‘weaken’	
feannag	[fjɑNak]	‘lazybed’	
greannach	[krʲɑNəx]	‘angry’	
		/a/: Before /L/	
balach	[pɑLəx]	‘boy’	
dealan	[tʲɑLan]	‘electricity’	
geal	[kʲɑL]	‘white’	
salainn	[sɑLiNʲ]	‘salt’	
		/a/: After /L/	
blas	[pLɑs]	‘taste’	
cladach	[kʰLɑt̪əx]	‘shore’	
gloinne	[kLɑNʲə]	‘glass’	
langa	[Lɑ̃ɣə]	‘ling’	
		/a/: Before /R/	
a’ gearradh	[ə kʲɑRəɣ]	‘cutting’	
earrach	[jɑRəx]	‘spring’	
starrag	[st̪ɑRak]	‘crow’	
tarraing	[t̪ʰɑRikʲ]	‘pull’	
		/a/: After /R/	
rag	[Rɑk]	‘numb’	
raineach	[Rɑnəx]	‘bracken’	
rapach	[Rɑʰpəx]	‘rough’	
reamhar	[Rɑ̃vər]	‘fat’	
		/a/: Before retroflex	
arspag	[ɑʂˠpak]	‘black-backed gull’	
cairteal	[kʰɑʂˠt̪ˠalʲ]	‘quarter’	

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ceart	[kʲʰɑʂˠʈˠ]	'correct'	
neart	[Nʲɑʂˠʈˠ]	'strength'	
/a/: Before xk			
cleachd	[kʰlʲaxk∼kʰlʲɑʰk]	'use'	S2,3,4,6,9: [xk]; S1,5,7,8: [ʰk]
seachd	[ʃaxk∼ʃɑʰk]	'seven'	
sneachda	[ʃNʲãxk∼ʃNʲɑ̃ʰk]	'correct'	
tachd	[t̪ʰaxk∼t̪ʰɑʰk]	'choke'	
/iː/			
cìr	[kʲʰiːrʲ]	'comb'	
ìm	[iːm]	'butter'	
mìle	[mĩːlʲə]	'thousand'	
rìgh	[Riː]	'king'	
sgìth	[skʲiː]	'tired'	
sgrìobh	[skrʲiːv]	'write'	
tìr	[tʲʰiːrʲ]	'land'	
trì	[t̪ʰriː]	'three'	
/ɯː/			
aodann	[ɯːt̪əN]	'face'	
caol	[kʰɯːL]	'narrow'	
caora	[kʰɯːrə]	'sheep'	
craobh	[kʰrɯːv]	'tree'	
faoileag	[fɯːlʲak]	'seagull'	
fraoch	[frɯːx]	'heather'	
maol	[mɯ̃ːL]	'bald'	
saor	[sɯːr]	'free'	
/eː/			
an-dè	[əˈNʲeː]	'yesterday'	
cèir	[kʲʰeːrʲ]	'wax'	
cnàimh	[kʰrʲẽːv]	'bone'	S2,7: /aː/
èirich	[eːrʲixʲ]	'rise'	
fèis	[feːʃ]	'festival'	
leugh	[Lʲeːv]	'read'	
pàipear	[pʰeːʰparʲ]	'paper'	
Seumas	[ʃeːməs]	'James'	
/aː/: Non-retracting			
àite	[aːʰtʲ]	'place'	
a-màireach	[əˈmãːrəx]	'tomorrow'	
àrach	[aːrəx]	'upbringing'	
àradh	[aːrə]	'ladder'	
càil	[kʰaːlʲ]	'nothing'	
cànan	[kʰaːnan]	'language'	
fàg	[faːk]	'leave'	
màthair	[mãːhərʲ]	'mother'	
pàrant	[pʰaːrəN̥t̪]	'parent'	
sàil	[saːlʲ]	'heel'	
snàmh	[sNãːv]	'swim'	
tràigh	[t̪ʰraːj]	'beach'	
/aː/: Before /L/			
àlainn	[ɑːLiNʲ]	'beautiful'	
càl	[kʰɑːL]	'cabbage'	
sàl	[sɑːL]	'seawater'	
Teàrlach	[tʲʰɑːLəx]	'Charlie'	S4,5,6: [ɭˠ]
/aː/: After /L/			
blàth	[pLɑː]	'warm'	
làidir	[Lɑːtʲərʲ]	'strong'	

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làmh	[Lɑ̃:v]	‘hand’	
làn	[Lɑ:n]	‘full’	
		/a:/: Before /R/	
bàrr	[pɑ:R]	‘cream’	
gàrradh	[kɑ:Rəɣ]	‘garden’	
geàrr	[kʲɑ:R]	‘hare’	
nas fheàrr	[nə ʃɑ:R]	‘better’	
		/a:/: After /R/	
ràcan	[Rɑ:ʰkan]	‘rake’	
ràith	[Rɑ:xʲ]	‘quarter year’	
ràmh	[Rɑ̃:v]	‘oar’	
ràn	[Rɑ:n]	‘cry’	
		/a:/: Before retroflex	
DiMàirt	[tʲəˈmɑ̃:ʂˠʈˠ]	‘Tuesday’	
gàrdan	[kɑ:ʈˠan]	‘arm’	
mèirleach	[mjɑ̃:ɭˠəx]	‘thief’	S9: [L]
tàirneanaich	[t̪ʰɑ:ɳˠanixʲ]	‘thunder’	

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