

Feature specifications and contrast in vowel harmony:
The orthography and phonology of Old Norwegian height harmony

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Declaration

I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where stated otherwise by reference or acknowledgment, the work presented is entirely my own.

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Abstract

In this thesis, I provide a new approach to the role of phonological patterning in determining the featural content of phonological relations and the size and shape of sound inventories. The empirical scope of this project has particular focus on vowel harmony and vocalic features with an extended case study of Old Norwegian. Vowel harmony, simply defined, is a process where vowels in a word show systematic correspondence for some feature. Because of its many moving parts and obvious class behaviour, vowel harmony and harmony languages provide one of the best laboratories for exploring the emergence, acquisition, specification, and common patterning of phonological features.

In chapter 1 I provide an introduction to Old Norwegian vowel harmony and some unexplained harmony exceptions. This chapter explores parallel phenomena in the typology of harmony languages and the theoretical challenges these patterns pose. In particular, I illustrate that non-harmonising segments display three distinct behaviours with respect to phonological activity and visibility while the core components of popular grammatical and representational approaches to vowel harmony commonly only predict two. I suggest the solution to this problem lies in the representation and definition of phonological contrastivity.

Chapter 2 presents the principal components of a new approach to the acquisition and specification of features using a version of Contrastive Hierarchy Theory (Dresher, Piggott & Rice 1994; D. C. Hall 2007; Dresher 2003, 2009) which incorporates emergent and substance-free features and feature-nodes (Iosad 2017a). In this chapter I argue that phonological features, segments, feature classes, and whole sound inventories emerge according to the Correlate Contrastivist Hypothesis which holds that a language's phonemic inventory is defined by the set of active phonological features required to express the language's phonological regularities. Drawing insights from Westergaard's (2009, 2013, 2014) model of micro-cues, I posit that language learners generalise small pieces of abstract linguistic structures ('micro-cues') in the form of features and feature co-occurrence restrictions while parsing linguistic input. In the course of language acquisition, these micro-cues accumulate, and the sum of these cues defines a sound inventory. I argue a segment's feature specifications and the shape of feature classes in a language are determined by a version of the Successive Division Algorithm (Dresher 2009, §7.8; D. C. Hall 2007, §1.2.7; Mackenzie 2013, 2016) which takes an ordered set of representational micro-cues as its input and returns a contrastively specified segment inventory as its output. Finally, this chapter demonstrates how these components combined with the hierarchical organisation of features afforded by the contrastive hierarchy architecture recapitulates all the important insights of feature geometry, providing an economical and principled model of phonological representations which narrowly vary cross-linguistically.

In chapter 3 I present a formal model of harmony using a licensing approach, adapted from Iosad (2017a) and Walker (2005), inspired by the recipient-oriented model of Nevins (2010). Using a detailed study of cross-dialectal microvariation in harmony and harmony neutrality in Yoruba (Atlantic-Congo), I demonstrate that this framework makes the right predictions, affording a ternary contrast in the behaviour of non-alternating harmony segments without any necessary additional grammatical mechanisms. A principal assumption of Contrastive Hierarchy Theory is that the hierarchical scope of features is cross-linguistically variable, and this chapter illustrates how variable feature ordering predicts common asymmetries across harmony languages in the presence or absence of required agreement for orthogonal features (so-called ‘parasitic harmony’). Specifically, the contrastive hierarchy derives parasitic harmony languages by nesting harmony feature contrasts within other featural divisions. This chapter closes with an exploration of the predicted typology of non-/parasitic systems and provides explicit diagnostics for identifying true vs. false parasitic harmony.

The theoretical chapters present a coherent, limited, and highly predictive model of phonological representations and vowel harmony, but the real value of a theory is whether it can provide new insights on questions which have otherwise resisted explanation. Old Norwegian vowels and vowel harmony represent such an example. Old Norwegian vowel harmony displays remarkably complex patterns, and its analysis is considerably complicated by the philological nature of available evidence. Chapter 4 presents the materials and methods I employ for the automated collection and phonological annotation of Old Norwegian vowel sequences in a corpus of mid-to-late 13th-century manuscripts. The corpus study’s data set is freely available online at <http://dx.doi.org/10.17613/gj6n-js33>.

Chapter 5 provides a grapho-phonological study of the Old Norwegian vowel inventory and segmental phonological patterns. This corpus study shows that Old Norwegian manuscripts display robust (pre-decay), transitional, and decayed vowel harmony, which provides invaluable empirical evidence for the otherwise poorly documented decay of harmony systems. The rest of the chapter provides a detailed survey of pre-decay Old Norwegian surface harmony patterns and their interaction with other sound processes and sound changes (e.g. umlauts, vowel deletions, and vowel mergers).

A major goal of this project has been to develop tangible heuristics for the reconstruction of historical phonological representations on the basis of phonological patterns evidenced in textual source material. Tying together this thesis’ theoretical and empirical components, I show in chapter 6 how the active vocalic features and feature co-occurrence restrictions in Old Norwegian can be discerned according to the Correlate Contrastivist Hypothesis. In turn, the intricate harmony and neutral harmony patterns in Old Norwegian receive a straightforward explanation following these representational generalisations. This case study illustrates how even complex harmony systems such as Old Norwegian can be reduced to simple emergent effects of the categorisation and co-occurrence of features in contrastive feature hierarchies. This chapter concludes with a historical phonological investigation of the implications of this harmony system for the status of other Old Norwegian sound patterns.

The main features of this thesis’ theoretical component and useful abstract schemata are provided in chapter 7 to aid in applying this framework to new data. For ease of

comparison, I provide an appendix with contrastive hierarchies and summaries of each harmony language cited in this thesis.

The unique contribution of Old Norwegian neutral harmony patterns within the typology of vowel harmony languages provides important evidence for the role of feature specifications and contrastivity in phonology. This thesis' broad typological and narrow empirical studies confirm the descriptive and explanatory adequacy of the proposed framework in providing novel insights on new and old problems regarding the link between phonological representations and phonological patterns.

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Part I

Introduction

Chapter 1

An Old Norwegian phonological riddle

1.1 Introduction

Early West Norse dialects (that is, c 12th-century Old Icelandic, Old Norwegian, Old Faroese, and Old Norn) are commonly reconstructed as having a fairly symmetric stressed vowel inventory: nine qualitatively distinctive monophthongs – each contrastive for length – as shown in Table 1.1 using normalised Old Norse representations (Küspert 1988, p. 170; Schulte 2002; Kristoffersen & Torp 2016, p. 118).¹ This is a fairly close phonological interpretation of the vowel inventory proposed by the *First Grammatical Treatise* of Iceland (AM 242 fol.), a mid-12th-century work on Old Icelandic phonology and orthography which provides an explicit demonstration of the sound inventory of Old Icelandic using qualitative/quantitative minimal pairs.

Table 1.1: Traditional reconstruction of Old Norse vowels

FRONT		BACK		
NON-ROUND	ROUND	NON-ROUND	ROUND	
i	y		u	HIGH
e	ø		o	MID
æ		a	ɔ	LOW

The phonemic inventory in Table 1.1 is broadly generalisable across Early West Norse varieties. Central dialects of Old Norwegian (c 12th–14th centuries) set themselves apart in how these vowels are distributed in unstressed syllables. In contrast to other West Norse dialects, Old Norwegian displays an otherwise rare form of height harmony via vowel lowering, resulting in alternations of high/non-high *i/e* and *u/o* vowels in unstressed (non-initial) syllables (Hødnebo 1977, Myrvoll 2014, Sandstedt 2017). In the way of a simple definition, vowel harmony is a process in which vowels in a word show systematic correspondence for some feature. The basic harmony generalisation for Old Norwegian is that unstressed (non-initial) high vowels follow high (stressed) vowels while unstressed non-high vowels follow non-high vowels, as shown by alternating dative suffixes in (1). The data are here represented in semi-normalised Old Norse spellings; acute accents mark

¹For an overview of the historical development of the Old Norse vowel inventory, see Schulte & Williams (2018), Schulte (2018), and Haugen (2012, 2018).

long vowels. For the sake of clarity, I have underlined the harmony triggers. Orthographic data from manuscript sources are provided in angle brackets; italicised text represents abbreviated letters in the source material.²

(1) **Height harmonic alternations in inflectional suffixes**

a.	'skip-i	<fkipi>	'skip-um	<fkipum>	'ship'-DAT.SG./PL.
b.	'dýr-i	<dyri>	'dýr-um	<dyrum>	'animal'-DAT.SG./PL.
c.	'hús-i	<hufi>	'hús-um	<hufum>	'house'-DAT.SG./PL.
d.	'veg-e	<vege>	'veg-om	<vegom>	'way'-DAT.SG./PL.
e.	'dóm-e	<døme>	'dóm-om	<dømom>	'example'-DAT.SG./PL.
f.	'dóm-e	<dome>	'dóm-om	<domom>	'judgement'-DAT.SG./PL.
g.	'hætt-e	<hætte>	'hött-om	<hattom>	'mode of life'-DAT.SG./PL.
h.	'mál-e	<male>	'mól-om	<malom>	'matter'-DAT.SG./PL.

The data in (1) display a simple pattern, which is robustly attested in a wide range of Norwegian manuscript, charter, and runic material. High inflectional vowels /i, u/ surface as high [i, u] when following high vowels but lower to [e, o] following non-high vowels. There is, however, an unresolved mystery in Old Norwegian vowel harmony. The simple patterns in (1) are complicated by two exceptional vowels: the short variants of normalised orthographic *æ-ø*, represented variably in Old Norwegian writing chiefly as <æ, e> and <o, a>, respectively.³ Already in the earliest descriptions of Old Norwegian vowel harmony (e.g. Keyser & Unger 1849, Hægstad 1899), it was recognised that these vowels – regardless of their variable spelling – categorically fail to initiate vowel lowering and take high vowel suffixes: e.g. height disharmonic *æmn-i*, not **æmn-e*. In other words, short *æ-ø* are reconstructed as low vowels in Table 1.1 but are variably spelled like mid vowels in Old Norwegian textual sources and exceptionally pattern with high vowels in height harmony.

(2) **Harmonically neutral short *æ* and *ø***

a.	'hæll-i	<hælli>	'hæll-um	<hellum>	'cave'-DAT.SG./PL.
b.	'æmn-i	<emni>	'æmn-um	<æmnum>	'stuff'-DAT.SG./PL.
c.	'søðrl-i	<foðrli>	'søðl-um	<foðlum>	'saddle'-DAT.SG./PL.
d.	'fjotr-i	<fiotri>	'fjotr-um	<fiotrum>	'fetter'-DAT.SG./PL.

A second peculiar characteristic in the behaviour of *æ-ø* vowels is that they block height harmony in non-initial positions. The distribution of short *æ-ø* vowels in such positions is for etymological reasons very limited, but when found in non-initial syllables, *æ-ø* do not

²Old Norwegian height harmony featured considerable geographic and chronological variation – explored in greater detail in sections 4.1/5.3. For the sake of uniformity, the data in this section are collected from the following manuscripts: *The Legendary Saga of St. Olaf* (De la Gardie 8 fol, 70v–110v – c 1225–50) and *The Saga of Barlaam and Josephat* (Holm perg 6 fol – c 1275). See sections 4.3.3/4.3.4 for philological and codicological details. A facsimile of the De la Gardie 8 manuscript is provided in Fig. 1.2.

³Short *æ-ø* feature considerably more spelling variation than other vowels in Old Norwegian writing, primarily because of sound–letter asymmetries. For instance, *fjotri* – <fiotri, fiatri> and *hælli* – <hælli, helli> in (2) above. Occasionally, these two vowels are also represented digraphically (e.g. <ei, au, ao>) or as ligatures (e.g. <æ, ø, a>). The implications of this spelling variation for the phonological representation of Old Norwegian vowels are further explored in section 5.1.

alternate regardless of preceding vowels and block harmonic lowering: e.g. *akkæri*, not **akkære*. In other words, these vowels are *neutral* (non-alternating) non-undergoers of height harmony and *inert* or *inactive* non-triggers of harmony alternations. Though these segments are neutral and inactive with respect to height harmony, they are nevertheless *visible* harmony targets insofar as harmony does not spread across them (3). Put concisely, *æ–ø* vowels are *neutral blockers*: not initiating harmony in trigger positions (2) and halting the spread of height harmony in target positions (3).

(3) **Short *æ* and *ø* block height harmony in non-initial positions**

- | | | | | |
|----|-------------|--------------|------------|--------------------------------|
| a. | 'missæri | *'missære | <misseri> | 'season'-ACC.PL. |
| b. | 'akkæri | *'akkære | <Akcæri> | 'anchor'-ACC.SG |
| c. | 'frið-øst-u | *'frið-øst-o | <friðaztu> | 'beautiful'-SUPER.-DEF.ACC.PL. |
| d. | 'orrøst-u | *'orrøst-o | <orroftu> | 'battle'-DAT.SG. |

The patterns in (2–3) are widely attested in 12th–13th-century Old Norwegian textual material (Keyser & Unger 1849; Hægstad 1899, 1907; S. Johnsen 2003). Though these patterns are well known among Norse philologists, the cause of this harmony neutrality remains an unresolved riddle. These patterns are unexpected for a number of reasons.

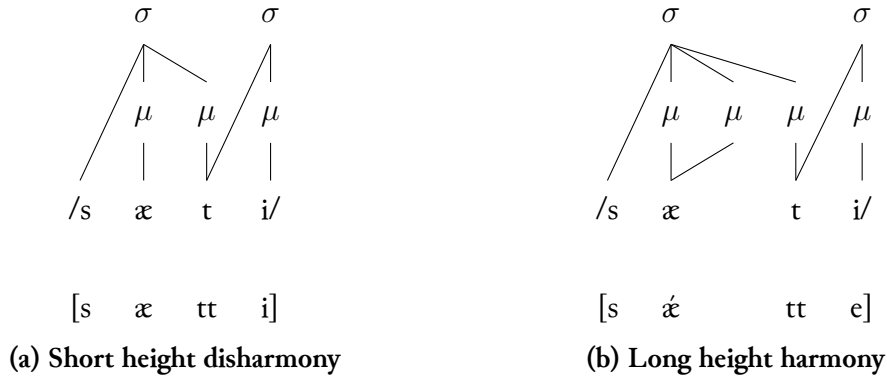
First, the vowels' corresponding long counterparts *æ–ø* are always harmonic triggers; see (1gh) and (4bd). In other words, according to the traditional representation of Old Norwegian vowels in Table 1.1, these data suggest that Old Norwegian height harmony is minimally contingent on vowel length, as exemplified by the near minimal pairs in (4) below.

(4) **Old Norwegian apparent neutrality–length correlations**

- | | | | | |
|----|---------|----------|----------|------------------------------|
| a. | 'sætti | *'sætte | <fætti> | 'set'-PRET.INDIC.3.SG. |
| b. | 'sætte | *'sætti | <fætte> | 'reconcile'-PRET.INDIC.3.SG. |
| c. | 'jǫrðum | *'jǫrðom | <jardum> | 'earth'-DAT.PL. |
| d. | 'tǫrom | *'tǫrum | <tarom> | 'tear'-DAT.PL. |

The apparent length condition in (4) is highly suspicious. No other vowels display such length conditions in Old Norwegian. For example, both short and long counterparts of low /a, á/ trigger harmonic lowering: e.g. *ráð-e* 'counsel'-DAT.SG. and *lað-e*, not **lað-i* 'pile'-DAT.SG. Moreover, there is little evidence that neutral harmony in other harmony languages is ever conditioned or constrained by differences in vowel length alone in the absence of other qualitative or prosodic differences (Gunnar Ólafur Hansson 2001, pp. 245–51). This fact suggests harmony processes only have reference to segmental features and not higher prosodic positions. If this is correct, and if we represent vowel length as an association between segments to higher-level timing units (Hyman 1985, McCarthy & Prince 1996), then different harmony patterns are not predicted to be possible in the minimal pairs in (4) since the stressed vowels in these examples are featurally identical on the root tier, as shown in Fig. 1.1. According to these representations, it is predicted that *æ–é* should display symmetric/identical harmony behaviours since they are featurally identical at the segmental level according to the traditional representations in Table 1.1.

Figure 1.1: Moraic representations of vowel length in Old Norwegian



In addition to the aforementioned theoretical/typological issues, the divergent $\text{æ}-\text{ø}$ and $\text{é}-\text{ǿ}$ harmony patterns in Old Norwegian are also unexpected given the common historical development of these vowels. Specifically, short $\text{æ}-\text{ø}$ and long $\text{é}-\text{ǿ}$ are assumed to have emerged as symmetric products of historical leftwards fronting and rounding (i/j - and u/w -umlaut) of Proto-Norse $*a/\acute{a}$ vowels. I provide some examples below in (5).⁴

(5) $\text{æ}-\text{ø}$ / $\text{é}-\text{ǿ}$ symmetric historical development

Old Norwegian		Proto-Norse	
<u>æ</u> mn̥i	<	*ab̥n̥ija	‘stuff’-NOM.SG.
s <u>ǿ</u> ðull	<	*saðulaR	‘saddle’-NOM.SG.
h <u>ǿ</u> tt̥r	<	*háttuR	‘mode of life’-NOM.SG.
h <u>ǿ</u> tti	<	*háttiju	‘mode of life’-DAT.SG.

In sum, the short vowels $\text{æ}-\text{ø}$ constitute a unique vowel class – as evidenced by their distinct harmony patterns in (3, 4) above – but it is not clear what distinguishes these vowels phonologically or what motivates their divergent harmony behaviour. Following traditional assumptions of Old Norwegian vowels, there is no clear secondary feature or obvious characteristic which should set these vowels apart from other (harmonic) non-high vowels. Given the traditional representations in Table 1.1 which are informed by the presumed historical development of low vowels in (5), we would expect $\text{æ}-\text{ø}$ to be height harmonic like any other non-high vowel in Old Norwegian. Attempts have been made to constrain Old Norwegian height harmony via conditions on vowel length (Hagland 1978a,b), featural similarity (Rajić 1975, 1980), or typologically rare and unlikely phonological representations (Grønvik 1998), none of which adequately explains all the facts and none of which has received any consensus; cf. Schulte (2002, p. 891): ‘Although this deviation has been observed by several scholars, it defies a proper solution’.⁵ Why Old

⁴Proto-Norse reconstructions in this thesis are based on the work of Iversen (1955), Krause (1971), and Haugen (2012).

⁵For more detailed overviews of previous philological literature on Old Norwegian vowel harmony, see Myrvoll (2014) and Sandstedt (2017).

Norwegian $\text{æ}-\varnothing$ does not trigger harmonic lowering and what motivates their harmony blocking patterns remains one of the most contested, classical problems in Norwegian historical phonology.

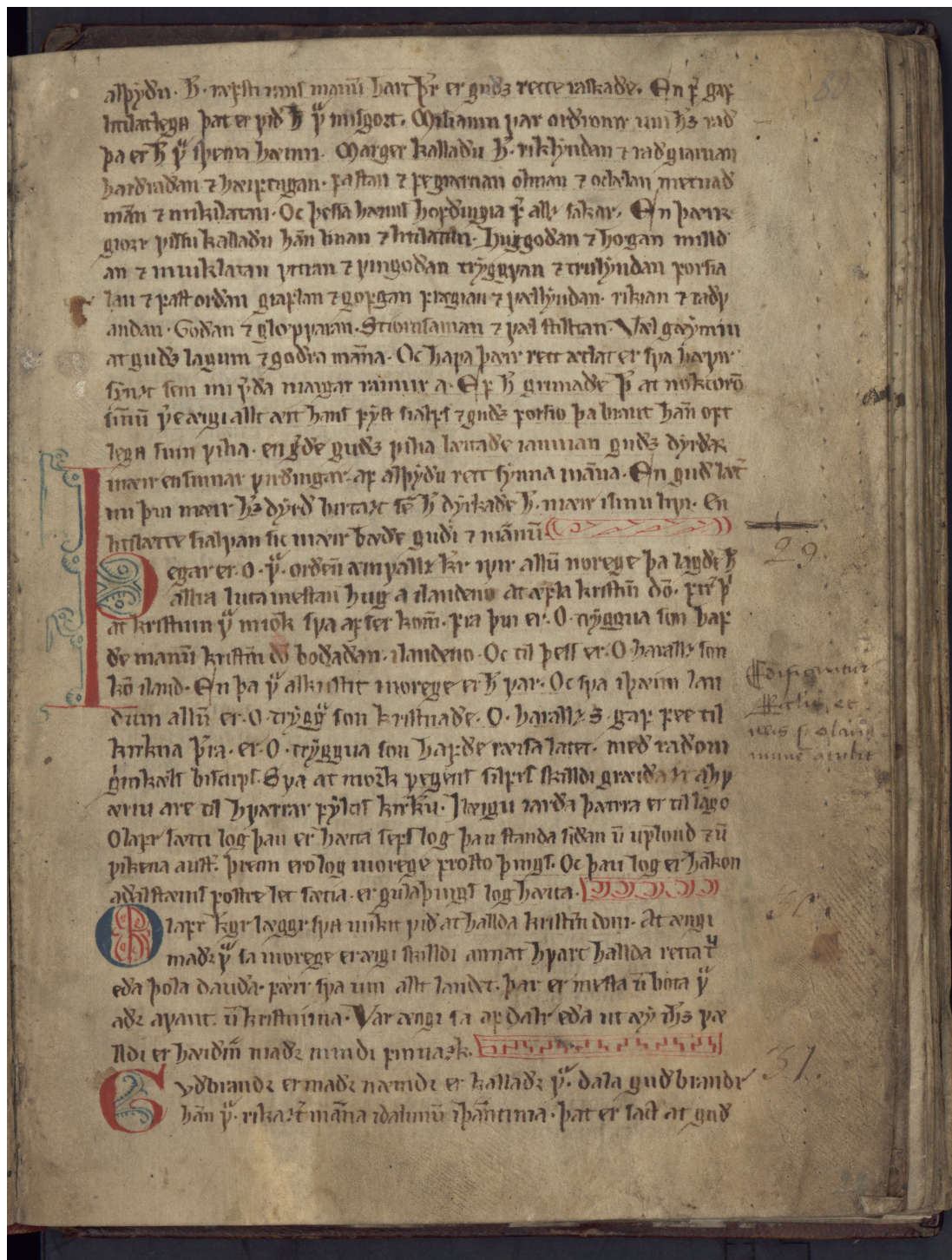


Figure 1.2: An excerpt from the *Legendary Saga of St. Olaf* (De la Gardie 8 II fol., c. 1225–50). Uppsala University Library. Fol. 81r.

1.1.1 The Old Norwegian riddle in other languages

While it is not well recognised among Norse philologists, the kinds of neutral harmony patterns observed in Old Norwegian above are actually quite common among the world's harmony languages. In fact, the form of neutral blocking displayed by Old Norwegian $\text{æ}-\varnothing$ vowels is the normal behaviour of low vowels in structurally similar lowering harmony systems. These patterns are widely attested in Bantu height harmony systems; see Hyman (1999) and Odden (2015) for typological overviews.

An example of Bantu height harmony with Old Norwegian-like neutral blocking is provided in (6) by Chewa (N.31; aka Chewa-Nyanja, Nyanja-Chewa, Chichewa), spoken in Zambia, Malawi, and Mozambique (Downing & Mtenje 2017).⁶ Chewa features a simple five vowel system /i, e, a, o, u/ and displays lowering harmony where, like Old Norwegian, high /i, u/ lower to [e, o] following non-high vowels. As shown in (6), non-low vowels in non-initial syllables correspond in vowel height to root-initial syllables (the so-called 'final-vowel suffix' /-a/ does not harmonise). Chewa represents the 'canonical' pattern of Bantu height harmony in which low /a/ is fully neutral (a non-trigger/non-target). For clarity's sake, as is common in Bantu height harmony studies, I do not represent verbal prefixes, which are always extra-harmonic/non-harmonising: e.g. [ku-tsék-el-a], not *[ko-tsék-el-a].⁷ See Downing & Mtenje (2017) for further details. Like Old Norwegian $\text{æ}-\varnothing$, Chewa *a* takes high vowel suffixes: e.g. [vǎl-il-a], not *[vǎl-el-a].

(6) Chewa height harmony with neutral low vowels

HIGH	phík-il-a	'cook'-APPL.-FV.	túm-il-a	'send'-APPL.-FV.
MID	tsék-el-a	'close'-APPL.-FV.	gón-él-á	'sleep'-APPL.-FV.
LOW	vǎl-il-a	'get dressed'-APPL.-FV.		
	*vǎl-el-a			

The inventory shape of the two languages differs, and we are therefore dealing with different neutral blocking segments, but the phonological behaviour of Old Norwegian $\text{æ}-\varnothing$ and Chewa *a* are exactly the same. Both fail to trigger harmonic lowering, and in non-initial positions Chewa /a/ blocks height harmony from spreading across itself, resulting in word-medial disharmony: for example, [wǎlam-il-a], not *[wǎlam-el-a]. These patterns are illustrated in (7) below. In sum, Old Norwegian $\text{æ}-\varnothing$ and Chewa *a* are examples of the same phenomenon: visible but inert harmony targets which neutrally block height harmony in non-initial positions. They are non-high vowels which nevertheless pattern with high [i, u].

⁶Bantu languages often have variant and sometimes ambiguous names. To help with their identification and classification, Bantu languages are conventionally divided up into geographic zones (lettered A–S) and numbered subgroups (e.g. N.31 Chewa). These classifications were first proposed by Guthrie (1948, 1970), and a revised and updated online list of these referential classifications is provided by Maho (2009). For clarity's sake, when referencing Bantu languages, I follow Maho's conventions.

⁷Like many Eastern and Southern Bantu languages, Chewa displays penultimate lengthening as a reflex of predictable stress placement: e.g. [góon-a] 'to sleep' but [gón-éél-á] 'to sleep on something' (Hyman 2009, Downing & Mtenje 2017). Vowel length has no effect on harmony patterns, and for ease of explication of the harmony system, I do not represent vowel lengthening in Chewa or other related Bantu varieties in this thesis.

(7) **Chewa neutral blocking /a/ with applicative and causative [-il, -its] suffixes**

HIGH	ch <u>ĩ</u> nga-il-a	‘welcome someone’	l <u>ũ</u> ngam-its-a	‘make righteous’
NON-HIGH	w <u>e</u> lam-il-a	‘bend’	p <u>o</u> lam-il-a	‘stoop’
	*w <u>e</u> lam-el-a		*p <u>o</u> lam-el-a	

Height harmony neutral blocking is thus not just a riddle for Norse philology but for the study of harmony and vowel systems around the world. For Norse philologists, this is a fortunate circumstance. On the basis of Norse philology alone, all we know for sure is that normalised, short *æ–ø* result in neutrally blocked harmony patterns. Why this is the case and how these vowels are phonologically represented and relate to other Old Norwegian vowels is up to linguistic interpretation. A cross-linguistic study of what motivates the same kinds of patterns in other languages can provide valuable insights on Old Norwegian vowels which medieval textual material alone cannot supply. For this purpose, we can use the Bantu (or more broadly Niger-Congo) language family as a kind of laboratory for investigating the nature and variation of vowel systems and vowel harmony, cf. [Odden \(2015, p. 29\)](#):

A desideratum of general linguistic theorizing is some method of validating claims about the nature of human language. In the realm of grammatical theory, it is often difficult to fill this lacuna as it pertains to phonology, since it is impossible to construct specific grammars to see if they are learnable, or to see whether one kind of fact entails another. Instead, we must observe what types of languages exist. The phonology of Bantu languages is of particular interest for testing grammatical theories, because on the one hand one can find a high degree of sameness in many aspects of their grammars, but on the other hand one also encounters a high degree of difference between languages in specific details. That is, Bantu languages as a whole constitute a naturally occurring controlled experiment that varies the building blocks of phonological systems.

The nature, domain, and causes of harmony neutrality in harmony languages is an area of ongoing research, but using the ‘controlled experiment’ provided by microvariation between Bantu height harmony systems, we can provide the appropriate typological context for Old Norwegian height harmony and harmony neutrality. This exploration of corresponding sound processes in structurally similar harmony languages helps shed light on the factors at play in similar patterns in Old Norwegian.

1.2 The where and why of harmony neutrality

The greater typological coverage of lesser-studied harmony languages in recent decades has provided a great number of valuable insights into the patterning of harmony systems. The most important condition which correlates with dis/harmony across harmony languages and which has been a major focus of research in vowel harmony studies is the role of phonological contrastivity ([Kiparsky & Pajusalu 2006](#), [Dresher 2009](#), [Nevins 2010](#), [van der Hulst 2018](#)). In this section, I explore the role of non-/contrastivity in different forms of harmony and harmony neutrality in Finnish and two additional, illustrative Bantu languages: Mbunda (K.15, [Gowlett 1970](#)) and Ndendeule (N.101, [Ngonyani 2004](#)). This typology provides important diagnostics for the nature of different kinds

of harmony neutrality in harmony languages. Using this typology, I identify consistent shortcomings of common grammatical and representational approaches to harmony phenomena, illustrating the need for a new model.

1.2.1 Harmony is limited by phonological contrast

As we have seen in the harmony data in (6) above, harmony neutrality in Chewa is correlated with an inventory asymmetry. Chewa displays harmonising, symmetric /i, e, u, o/ but neutral, unpaired /a/. Various explanations have been proposed for the exceptional behaviour of low vowels in canonical Bantu height harmony. For instance, according to articulatory- or acoustic-based feature theories, [high]/[low] are per definition exclusive since their combination is physiologically impossible. An example is provided by the definitions of [high]/[low] following Chomsky & Halle (1968, p. 304–05), reproduced in (8, 9).

(8) **SPE definition of HIGH/Non-HIGH**

High sounds are produced by raising the body of the tongue above the level that it occupies in the neutral position; non-high sounds are produced without such a raising of the tongue body.

(9) **SPE definition of Low/Non-Low**

Low sounds are produced by lowering the body of the tongue below the level that it occupies in the neutral position; non-low sounds are produced without such a lowering of the body of the tongue.

The incompatibility of these features has been taken as motivation for high ranking low-faithfulness in positional faithfulness/markedness accounts (cf. Beckman 1997, Nichols 2018); in other words, low vowels in the input should not be changed in the output. This prevents low /a/ and non-low /i, e, u, o/ from sharing spreading aperture or VPlace nodes, resulting in non-harmonising low vowels. Alternatively, [+low] may be construed as incompatible with [high] simply by the fact that [low] and [high] specifications are mutually predictable in a three vowel height system like Chewa: [+low] → [−high] and [+high] → [−low]. In underspecificational approaches, this may motivate the underspecification of [+low] vowels for [high] and vice versa; that is, that [+low] vowels have no [high] specification, inhibiting low vowels from undergoing or triggering height harmony (Moto 1989; cf. also Harris 1994 and Downing & Mtenje 2017).

Another possibility is that /a/-neutrality is the more general effect of inventory asymmetries; that is, the lack of a [+high] harmony-pair for /a/ to alternate with motivates harmony neutrality, irrespective of the predictability or incompatibility of [low]/[high] features. Specifically, in a three-way distinction such as /i, e, a/, only two segments can constitute a minimal pair (i.e. [±high] /i, e/) to the exclusion of the third, which necessarily will differ with respect to two features (i.e. [+high, −low] /i/ vs. [−high, +low] /a/). In other words, the vowels /i, e/ are minimally distinguished by the harmony feature [±high] and are therefore potential harmony triggers/targets in Chewa, but there is no minimal [+high, +low] pair for [−high, +low] /a/ to alternate with, making /a/

necessarily neutral with respect to [+high]. We observe the same kind of neutrality-by-inventory-asymmetries in other non-height harmony systems, such as Finnish front-back harmony. Like Chewa, Finnish also displays uneven vowel classes, as illustrated by the Finnish inventory in Table 1.2. For clarity's sake, harmonising front/back vowels are coloured.

Table 1.2: Finnish uneven distribution of front-back vowels

	FRONT		BACK	
	NON-ROUND	ROUND	NON-ROUND	ROUND
HIGH	i	y	*u	u
MID	e	ö	*ø	o
LOW	ä		a	

As illustrated below in (10), Finnish displays rightwards or perseveratory backness harmony; in other words, non-initial vowels harmonise in vowel backness to preceding vowels. Though the front vowels /i, e/ are not, in principle, incompatible with [+back] in the same way that [+low] vowels are potentially incompatible with [+high], /i, e/ nevertheless display the same asymmetry. /i, e/ lack corresponding [+back]-pairs – i.e. non-round, back */u, ø/ – and fail to undergo harmony in contrast to other (harmonically paired) vowels. In Finnish, /i, e/ are fully neutral and ‘transparent’ (i.e. invisible) to backness harmony; that is, non-alternating and co-occurring with both front and back vowels: e.g. [käde-llä] and [kodi-lla].

(10) **Finnish front/back alternations** (Ringen 1975, Ringen & Heinämäki 1999)

FRONT	käde-llä		‘hand’-ADESS.
	kesy-llä		‘tame’-ADESS
BACK	kodi-lla	*kodi-llä	‘home’-ADESS
	vero-lla	*verö-llä	‘tax’-ADESS

This correlation between harmony neutrality and inventory asymmetries in Chewa and Finnish suggests vowel harmony systems may be limited to segments which are contrastive or minimally paired for the harmony feature, relativising Chewa height harmony to [±high]-paired /i, u, e, o/ vowels to the exclusion of /a/ and Finnish backness harmony to [±back]-paired /ä, ö, y, a, o, u/ to the exclusion of /i, e/.

This is of course by no means an exhaustive review of all approaches to neutral harmony, but across frameworks, though the theoretical particulars may be packaged differently, phonologists are more or less in agreement that the neutrality of segments in vowel harmony systems is in some way limited by contrastivity or feature-pairing. Generalising the exact role of contrastivity in vowel harmony is nevertheless difficult since contrastivity is ultimately a theory-centric concept. As we shall see in greater detail below, two segments may be construed as contrastive under one framework but non-contrastive under another (Dresher 2013, 2014, 2015).

We can, however, make some basic observations. Morphological and positional restrictions aside, harmony feature-pairing ensures harmonisation. There are no languages where two segments /x/ and /y/ can be shown in their phonological behaviour to be

paired for a harmony feature $[\pm F]$ but nevertheless fail to undergo $[F]$ -harmony. In a similar vein, segments which fail to undergo harmony in all domains (categorically non-alternating segments) are always unpaired for the harmony feature. Finally, harmonising targets (i.e. alternating vowels in target positions) are also active harmony triggers in trigger positions; that is, harmonisation/feature-pairing guarantees feature-spreading in at least some domain. In some form then, harmony and harmony neutrality must be limited by phonological contrast.

1.2.2 Harmony is *not* limited by phonological contrast

In Chewa, and in fact most Bantu height harmony systems we find the tidy system above wherein $[\pm \text{high}]$ -paired vowels are harmonic while unpaired /a/ is not. Other well-known examples include Shona (S.10), Beckman (1997); Nandi or Kinande (JD.42), Mutaka (1995); Kisa (JE.32D), Hyman (1999); Ngoni of Tanzania (N.12), Ngonyani (2004); Yao (P.21), Ngunga (2000); among many others. However, the relationship between harmony neutrality and harmony-pairing is more nuanced than it might at first appear. In a number of other Bantu languages, low vowels *are* valid triggers of harmonic lowering, even though they are no more paired for the harmony feature than in Chewa. Such a pattern is found in Mbunda (K.15; aka Chimbunda, Kimbunda, or Mbuunda), spoken in Angola and Zambia (Gowlett 1970).

(11) Mbunda height harmony on APPL.-FV. /-il-a/

HIGH	<u>l</u> um-il-a	‘cultivate’	t <u>u</u> ng-il-a	‘build’
MID	n <u>e</u> n-el-a	‘bring’	o <u>c</u> -el-a	‘roast’
Low	kw <u>a</u> t-el-a	‘hold’		
	*kw <u>a</u> t-il-a			

The height harmony patterns in (11) produce a perfect division between high /i, u/ and non-high /e, o, a/. It may therefore seem ambiguous whether Mbunda harmony involves vowel lowering following /a/ or simply raising following /i, u/. Mbunda round vowel suffixes, however, provide clear orthogonal evidence that Mbunda involves harmonic lowering. Namely, Mbunda height harmony is conditional on vowel rounding, such that non-round suffixes like /-il/ will harmonise to any non-high vowel – e.g. [nen-el-a] and [oc-el-a] – but labial suffixes will only harmonise with other labial vowels, as demonstrated in (12) using the reversive extension /-ul/: e.g. height disharmonic [tek-ul-a], not *[tek-ol-a].⁸ This is an example of so-called *parasitic harmony* since height correspondence is in some way dependent or ‘parasitic’ on labial feature specifications (cf. Steriade 1981, Cole & Trigo 1988). This parasitic condition results in disharmony in non-round/round sequences, revealing the underlying height values. In labial contexts, (non-labial) /a/ also fails to initiate vowel lowering: e.g. [nang-ul-a], not *[nang-ol-a]. These examples of failed vowel harmony in labial contexts demonstrate that Mbunda height harmony involves vowel lowering like other Bantu languages with the unique exception that /a/ triggers

⁸The reversive extension indicates that the subject nullifies or undoes the action – e.g. [-zit-ul-] ‘untie’ in comparison to [-zit-] ‘tie’ – but the productivity of such extensions can be questioned (David Odden, p.c.) since many verbs lack corresponding simplex radicals without the extension (cf. Gowlett 1970). Nevertheless, the harmony behaviour of such extensions, regardless of their status, is fully regular and predictable.

lowering in non-labial contexts (11): e.g. [kwat-el-a], not *[kwat-il-a] like Chewa [vāl-il-a].

(12) **Mbunda height harmony is contingent on vowel rounding**

HIGH	zít-ul-a	‘untie’	kúp-ul-a	‘bail out’
MID	ték-ul-a	‘draw water’	tomb-ol-a	‘uproot’
	*ték-ol-a			
Low	nāng-ul-a	‘warn’		
	*nāng-ol-a			

Canonical Bantu height harmony languages like Chewa also display the same conditions on trigger/target agreement for [labial], as illustrated by the Chewa data in (13) below. In both Mbunda and Chewa, round /-ul/ will only harmonise with other round vowels: e.g. Chewa [wónj-ol-a] but [tsék-ul-a], not *[tsék-ol-a]. See section 3.3 for further discussion of parasitic restrictions on vowel harmony.

(13) **Conditionally harmonising labial reversion /-ul/ in Chewa**

HIGH	pítíks-ul-a	‘overturn’	fúnth-ul-a	‘loosen’
MID	tsék-ul-a	‘open’	wónj-ol-a	‘spring a trap’
	*tsék-ol-a			
Low	sákh-ul-a	‘choose’		
	*sákh-ol-a			

The data above illustrate that Chewa and Mbunda are structurally extremely similar, displaying the same applicative [-il, -el] alternations and the same conditions on reversion [-ul, -ol] harmony. They differ specifically in the behaviour of /a/, which is unpaired and non-alternating in target positions in both languages but which triggers vowel lowering in Mbunda while not in Chewa. In addition to this basic dichotomy between harmonic or neutral unpaired segments, some languages display both Chewa- and Mbunda-type neutral and harmonic patterns simultaneously, such as in Ndendeule or Kindendeule (N.101), spoken in Namtumbo district, Ruvuma region of Tanzania (Ngonyani 2004). Ndendeule features a more complex seven vowel inventory and overlapping height and tongue root harmony, producing alternations in verbal extensions in relative height [-il, -el] as well as tongue root advancement / retraction [-el, -el].⁹

As illustrated in the inventory in Table 1.3, Ndendeule has effectively four vowel heights – /i, e, ε, a/ – with two distinct [±high]-unpaired groups. First, [–high, +low] /a/ which is unpaired for both [+high] and the tongue root feature, which we will label [–RTR] (i.e. non-retracted tongue root). Second, [–high, +RTR] /ε, ɔ/ lack corresponding [+high, +RTR] */I, u/ pairs.¹⁰ As shown in (14) below, though both /ε, ɔ/ and /a/ are

⁹Advanced and retracted tongue root – commonly abbreviated as ATR or RTR – describes the relative retraction of the tongue root during the pronunciation of vowels, particularly common among many West African languages; see Ladefoged & Maddieson (1996, pp. 300–6) for an overview.

¹⁰Because of the lack of harmony pairs, both /ε, ɔ/ and /a/ are predictably neutral or non-alternating with respect to [±high]-harmony in Ndendeule. This can be shown for /a/ using the non-alternating reciprocal suffix /-an/ in [yig-an-a] ‘imitate each other’, [pɛng-an-a] ‘block each other’, and [kɛm-an-a] ‘call each other’. Suffixes with underlying /ε, ɔ/ vowels are however uncommon since tongue root contrasts are typically restricted to root-initial positions (Ngonyani 2004).

Table 1.3: Ndendeule uneven distribution of high–non-high vowels

		FRONT	
		NON-ROUND	ROUND
HIGH		<i>i</i>	<i>u</i>
		* _I	* _U
MID	ATR	<i>e</i>	<i>o</i>
	RTR	<i>ɛ</i>	<i>ɔ</i>
LOW		<i>a</i>	

unpaired for the height harmony feature in Ndendeule, they display differing behaviours in root-initial (trigger) positions. The retracted /*ɛ*, *ɔ*/ vowels appear to trigger both vowel lowering and tongue root retraction on applicative suffixes (e.g. /i/ → [*ɛ*]) whereas /*a*/ triggers neither of them: i.e. [*kang-il-a*] and not *[*kang-el-a*] or *[*kang-ɛl-a*].

(14) Ndendeule (N.101) harmonic and neutral [+high]-unpaired segments

HIGH		y _i b-il-a	‘steal’	t _u l-il-a	‘skin’
MID	ATR	yemb-el-a	‘sing’	bol-el-a	‘teach’
	RTR	k _ɛ m-el-a	‘call’	t _ɔ l-el-a	‘take’
LOW		kang-il-a	‘push’		

The Ndendeule height harmony patterns in (14) combine both neutral and harmonic types, with lowering following paired /*e*, *o*/ and unpaired /*ɛ*, *ɔ*/ (similar to lowering following both paired /*e*, *o*/ and unpaired /*a*/ in Mbunda) but no lowering following /*a*/, just as in Chewa. Whether unpaired vowels initiate or fail to initiate harmony then is not predictable from the vowel inventory size and shape alone. A strong confirmation of this point is found in Old Norwegian, which displays the mirrored image of Ndendeule – without the tongue root harmony.

Old Norwegian also has two classes of non-alternating vowels in non-initial (target) positions – normalised, short *æ–ɔ* and *a* (which have previously been phonologically interpreted as Ndeundeule-like mid-lax /*ɛ*, *ɔ*/ and low /*a*/; cf. S. Johnsen 2003, Sandstedt 2017). As illustrated by the examples in (15), Old Norwegian unpaired segments also display two distinct harmony behaviours, but the behaviour of Old Norwegian short *æ–ɔ* and *a* or /*ɛ*, *ɔ*, *a*/ vowels in root-initial (trigger) positions is the reverse of Ndendeule. For clarity’s sake, I provide both phonological and normalised as well as non-normalised orthographic representations in (15) for comparison.

(15) Old Norwegian neutral and harmonic [+high]-unpaired segments

HIGH		‘liv-ir	<i>lifir</i>	<livir>	‘live’-2.SG.PRES.INDIC./SUBJ.
MID	TENSE	‘ger-er	<i>gerer</i>	<gerer>	‘do’-2.SG.PRES.INDIC./SUBJ.
	LAX	‘seg-ir	<i>sægir</i>	<sægir>	‘say’-2.SG.PRES.INDIC./SUBJ.
LOW		‘far-er	<i>farer</i>	<farer>	‘travel’-2.SG.PRES.SUBJ.

In Old Norwegian, in contrast to Ndendeule, /*a*/ triggers harmonic lowering while /*ɛ*, *ɔ*/ or *æ–ɔ* are neutral – not initiating lowering. In both languages, unpaired vowel classes are neutral in the sense that they are non-alternating or fail to undergo height harmony,

but whether neutral segments initiate harmony or not is apparently cross-linguistically variable. If the interpretation of the Old Norwegian vowels in (15) is correct, these data illustrate that harmonic and neutral vowel classes may even be articulatorily/acoustically overlapping, with neutral / ϵ / intervening between higher and lower harmonic / e , a / vowels.

In sum, harmony neutrality is related to contrastivity or feature-pairing insofar as featurally unpaired segments are necessarily non-alternating, but whether neutral or non-alternating segments initiate harmony is not predictable. As these Bantu and Old Norwegian height harmony comparisons demonstrate, whatever effect inventory shape or contrastivity has on harmony systems, it must be optional.

1.3 The locus of explanation in phonology

1.3.1 Grammatical vs. representational approaches

The survey of microvariation across Bantu languages in the preceding section demonstrates that there is a significant but somewhat nuanced relationship between contrastivity and harmony variation. In harmony languages, the set of active harmony participants appears to be optionally limited by harmony-pairing, such that some harmony systems are triggered by any harmonically specified segment (e.g. including [–high] / a / in Mbunda) while others include only harmonically paired segments (e.g. [\pm [high] / i , e / and / u , o / in Chewa to the exclusion of [+high]-unpaired / a /). This apparent dichotomy in harmony languages raises the question, how are these feature-pairing effects grammatically implemented and restricted?

Theoretical approaches to this question can be roughly divided into two types, focussing more on the function of contrastivity in harmony operations (grammatical approaches) or variation in the representations of the segments on which harmony operates (representational approaches). In other words, some frameworks assume / a / is more or less phonologically the same in Mbunda/Chewa while their harmony operations are grammatically different (e.g. the harmony rule may be limited in scope, applying only to contrastive segments in one language but not in another). Others posit that Mbunda/Chewa have grammatically identical harmony operations but assume / a / is underlyingly represented differently in the two languages (e.g. redundantly specified [–high] in one language but (non-contrastively) underspecified in another).

The truth could of course be somewhere in between, but for the sake of exploring the analytical challenges introduced by disharmony in harmony languages, let us explore these two contrasting approaches. There are a couple of novel vowel harmony frameworks quickly gaining currency which attribute an explicit role to contrastivity in curtailing harmony variation. These are Nevins' (2010) Search-and-Copy approach, which assumes parameters which limit the grammatical operation of harmony, and so-called Contrastive Hierarchy Theory or Modified Contrastive Specification (Dresher, Piggott & Rice 1994; D. C. Hall 2007; Dresher 2003, 2009; Iosad 2017a), which assumes variable ranking of featural contrasts, producing cross-linguistically varying feature specifications. These two frameworks are quite similar in motivation but differ in the weight they attribute to grammatical or representational differences in harmony languages.

Nevins' (2010) Search-and-Copy method is a principles-and-parameters framework. Building on the work of Calabrese (1995, 2005), he interprets differences between

languages like Mbunda and Chewa as evidence of parametric (grammatical) variation on vowel contrastivity. In other words, harmony rules are parameterised to apply to all vowels or alternatively only those which are contrastive for the harmony feature – resulting in broader or narrower sets of harmonising vowels across harmony languages with similar sound inventories. Nevins (2010) defines contrastivity by minimal differences (minimal-pairing) as in (16).

(16) **Definition of *contrastive*** (Nevins 2010, p. 70)

A segment S with specification αF in position P is *contrastive* for F if there is another segment S' in the inventory that can occur in P and is featurally identical to S, except that it is $-\alpha F$.

This method assumes full, universal feature specifications (e.g. Jakobson, Fant & Halle 1951; Chomsky & Halle 1968; Clements & Hume 1995). According to the definition in (16), /i, e/ are contrastive for [high] since they differ only with regard to their $[\pm\text{high}]$ -specification and are identically specified for all other features. /a/ is by this definition non-contrastive for [high] since there is no $[+\text{high}, +\text{low}]$ counterpart to /a/ with which it minimally differs. According to this framework, /a/ is assumed to be identically specified as $[-\text{high}]$ in both Chewa and Mbunda, but their harmony operations are grammatically different. A language's harmony rule or principle comes with a variety of different parameters which optionally limit harmony by contrastivity, locality, trigger/target similarity, and so on. In the case of Bantu height harmony, Nevins (2010, pp. 130–33) assumes a parameter on contrastivity which optionally limits the relevant set of visible or active harmony participants. He assumes that languages by default compute all segments bearing the harmony feature (including $[-\text{high}]$ /a/ in Mbunda) but some languages set the contrastivity-parameter to apply only to harmonically paired segments. Such contrastive relativisation would exclude /a/ (as in Chewa) which has no minimally paired $[+\text{high}, +\text{low}]$ counterpart.

This optional relativisation of visible/active harmony targets is functionally motivated. Contrastivity plays an important role not only in phonology but in human cognition more generally. Specifically, experimental research has shown that we pay particular attention to a given feature (in language or otherwise) where it defines a contrast (Nevins 2010, §3.4). In the case of vowel harmony, this approach assumes speakers are aware that /a/ is $[-\text{high}]$ in both languages, but they vary in whether their harmony process pays attention to this non-contrastive feature. This difference is formally defined in the harmony stipulations in (17, 18) using Nevins' notation.

(17) **Mbunda height harmony:**

Height-Harmonise: $F = [\pm\text{high}]$

(18) **Chewa height harmony:**

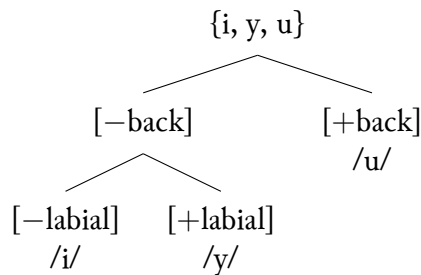
Height-Harmonise: $F = [\text{contrastive: } \pm\text{high}]$

According to the definitions in (17, 18), Mbunda and Chewa have very similar harmony applications except that Mbunda vowel harmony sees all $[\pm\text{high}]$ -specified segments – /i, e, u, o, a/ – while Chewa height harmony sees only harmonically paired segments: /i, e,

u, o/ to the exclusion of unpaired /a/. In other words, Chewa speakers only ‘care’ about $[\pm\text{high}]$ -specifications where they define a minimal difference while Mbunda speakers treat all contrastive and non-contrastive $[\pm\text{high}]$ -specifications alike.

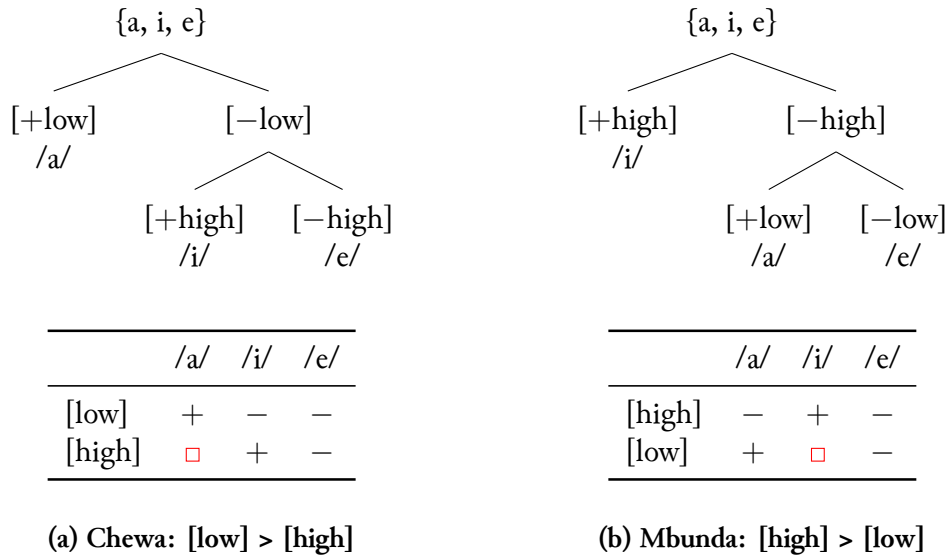
The harmony definitions in (17, 18) represent different categorisations – all $[\pm\text{high}]$ -specified vowels are categorised as harmonically active in (17) as opposed to only vowels with symmetric $[\pm\text{high}]$ divisions in (18). An equivalent representational way of doing the same thing is provided by Contrastive Hierarchy Theory or Modified Contrastive Specification (Dresher, Piggott & Rice 1994; D. C. Hall 2007; Dresher 2003, 2009; Iosad 2017a). This framework posits that a segment’s feature specifications are not fixed but depend on the size and shape of the language’s inventory. Specifically, Contrastive Hierarchy Theory posits that speakers define featural contrasts hierarchically – successively dividing their sound inventory up into binary groups using contrasting features. Following this approach, contrastive feature specifications are determined by feature domains in binary-branching trees. The first ordered feature will have scope over the entire inventory while successive feature divisions result in narrower and narrower feature domains. For example, given the three vowel inventory /i, y, u/ in Fig. 1.3, speakers might first divide the vowels broadly into front/back groups (i.e. $[-\text{back}]$ /i, y/ vs. $[\text{+back}]$ /u/) and more narrowly by labial/non-labial distinctions (i.e. $[-\text{labial}]$ /i/ vs. $[\text{+labial}]$ /y/). Under this account, [labial] only defines a contrast among front vowels. /u/ is underspecified for [labial].

Figure 1.3: Example contrastive feature hierarchy



This hypothesis has interesting implications for the shape and variability of phonological classes. It will be noted that when dividing up a set of things hierarchically, there are always two ways to make the divisions given any two features. The difference comes down to which feature has broader scope. For example, there are two ways we could categorise the set of high, mid, and low vowels in Mbunda/Chewa-like languages, as illustrated below in Fig. 1.4. For the moment, we will ignore labial contrasts.

As in Fig. 1.4a, speakers may first divide these vowels into low and non-low vowels; that is, $[\text{+low}]$ /a/ vs. $[-\text{low}]$ {i, e}. After this, non-low vowels could be sub-divided into high vs. non-high: i.e. $[\text{+high}]$ /i/ and $[-\text{high}]$ /e/. At this point, all members of the inventory are maximally discriminated from one another. Alternatively, we could do things the other way around, as in Fig. 1.4b. Here we first divide the set into high vs. non-high – that is, /i/ vs. {a, e} – and secondly into low and non-low: i.e. $[\text{+low}]$ /a/ and $[-\text{low}]$ /e/. For any two feature contrasts, there are these two logical possibilities. In the same set of steps, each member is fully distinguished, but we end up with slightly different categorisations. Either all segments are specified for [high] or only the ‘minimally paired’ /i, e/.

Figure 1.4: Alternative contrastive feature hierarchies of Bantu vowels

As these examples illustrate, these trees recapitulate the optional contrastive relativisation in Nevins' (2010) Search-and-Copy framework. In Fig. 1.4b, /a/ is specified [–high] (a lowering harmony trigger as in Mbunda) whereas it is underspecified for [high] in Fig. 1.4a – a harmonically neutral non-trigger, as in Chewa. However, instead of an independent grammatical parameter on the set of harmonising vowels, Contrastive Hierarchy Theory construes this difference as a matter of differing featural categorisation, resulting in differing phonological classes. The grammatical implementation in Chewa and Mbunda is assumed to be identical following this contrastive hierarchy analysis.

In essence, in the view of Contrastive Hierarchy Theory, Mbunda and Chewa speakers simply arrive at logical alternative solutions to the common problem of categorising an asymmetric set of vowels. Mbunda speakers first divide their sound inventory into the respective harmony classes (i.e. high /i/ vs. non-high /e, a/). By comparison, Chewa speakers divide their sound inventories first into harmonically paired vs. unpaired categories (i.e. non-low /i, e/ vs. low /a/). In Mbunda, after dividing into high/non-high categories, the inventory is further sub-divided into [±low]-classes to distinguish /e/ from /a/. /i/ has no [+low] counterpart and is therefore assumed to be underspecified for [low]. In Chewa, after dividing into [±high]-paired /i, e/ vs. unpaired /a/ categories, the inventory is further sub-divided into high/non-high classes to distinguish /i/ from /e/. /a/ has no [+high] counterpart and is therefore assumed to be underspecified for [high]. These differing feature specifications predict the observed differences in harmony classes. If language learners divide their asymmetric vowel inventory first by harmony classes into [+high] /i, u/ vs. [–high] /e, o, a/ vowels, then all vowels are contrastively specified for [high] (the Mbunda type). Alternatively, if speakers divide their inventory first into harmonically non-alternating [+low] /a/ vs. alternating [–low] /i, e, u, o/ vowels and then into [±high] classes, /a/ is underspecified for [high] – a neutral non-trigger. In this case, harmony is restricted only to ‘harmonically paired’ vowels (the Chewa type). Any asymmetric inventory will have these two logical possibilities.

The contrastive hierarchy method thus capitalises on the variation afforded by hierarchical categorisation to capture cross-linguistic variation in active feature specifications. Moreover, the number of possible categorisations for any given set is directly related to the size and complexity (or asymmetry) of the inventory of things to be categorised. These components predict that inventory asymmetries will be associated with cross-linguistic variation and that more complex sound inventories allow for more complex surface harmony patterns.

The two frameworks, Nevins' (2010) principles-and-parameters approach and Contrastive Hierarchy Theory, are thus very similar. Both attribute a crucial role to contrastivity in deriving harmony differences. In both approaches, asymmetric inventory shape therefore motivates harmony variation, capturing the typological link between harmony-pairing and harmony neutrality. The crucial differences come down to 1) how each framework defines *contrastivity* (i.e. via minimal-differences or by being dominated by a feature in contrastive hierarchies) and 2) the weight each theory attributes to grammatical and representational components in constraining variation. Where Nevins (2010) incorporates full, universal feature specifications, Contrastive Hierarchy Theory assumes feature specifications are cross-linguistically variable by optional feature ordering. Where Contrastive Hierarchy Theory assumes that harmony operations necessarily 'see' all feature specifications, Nevins (2010) assumes the visible/active set is cross-linguistically variable by optional contrastive relativisation. In either framework, whether the effect is captured grammatically or representationally, dis/harmony is equated with non-/contrastivity.

1.3.2 Problems with equating dis/harmony with non-/contrastivity

Both of these approaches provide interesting avenues for explaining the typological correlation between asymmetric inventory shape and neutral harmony since harmony variation and complexity is directly related in both cases to inventory variation and complexity. However, both accounts fall short in important respects. Crucially, both accounts equate phonological activity with phonological visibility. For harmony processes, a segment is *active* if it triggers harmony alternations and *visible* if it halts harmonic spreading in target positions.¹¹ Both approaches under consideration assume these factors are linked. For Nevins (2010), a harmony process either computes all feature specifications or only contrastive specifications (making all or only contrastive segments active harmony triggers and visible targets). In Contrastive Hierarchy Theory, a harmony feature either has scope over all or only some segments (making all or only some segments active triggers and visible targets). However, the behaviour of unpaired-non-alternating low vowels in Bantu height harmony is more complex this simple activity/visibility dichotomy would imply.

In (19), I contrast the behaviour of /a/ in initial and non-initial (trigger/target) positions in the three Bantu languages we have considered thus far. As illustrated by this comparison, segments are not simply active/visible or inactive/invisible, instead there is a ternary distinction in the surface behaviour of non-alternating segments in harmony

¹¹More specifically, a feature or segment is commonly assumed to be phonologically *active* or *visible* in derivational terms if it is present in the structural or applicational description of some rule (D. C. Hall & K. C. Hall 2016, Dresher 2017) or in non-derivational frameworks if it is referred to by an 'active' constraint (a constraint which is visible in at least some derivation; Kiparsky 2017). As I detail in this section, neutral blocking patterns as in Old Norwegian or Chewa, however, break these definitions.

languages. Specifically, these are *a*) active and visible harmonic blockers (the Mbunda type, [Gowlett 1970](#)) where /a/ always triggers harmonic lowering regardless of its position; *b*) transparent segments which are neither visible nor active (the Ndendeule type; Deo Ngonyani p.c. – cf. [Ngonyani 2004](#)) where /a/ triggers no harmony and can co-occur with vowels of any class; and *c*) inactive *but* visible neutral blockers (the Chewa type; [Downing & Mtenje 2017](#)) where /a/ is always followed by high vowels regardless of its position or any preceding potential harmonic triggers.

(19) /a/ in/activity and in/visibility across three Bantu languages

- a) Mbunda (K.15) harmonic blocking /a/:
- | | | | |
|------------|--------|---------|-------------|
| kwat-el-a | ‘hold’ | active | [a...e] |
| tumam-el-a | ‘sit’ | visible | [u...a...e] |
- b) Ndendeule (N.101) transparent /a/:
- | | | | |
|------------|-----------|-----------|-------------------------------|
| kang-il-a | ‘push’ | inactive | [a...i] |
| koβal-el-a | ‘stumble’ | invisible | [o...a...e], not *[o...a...i] |
- c) Chewa (N.31) neutral blocking /a/:
- | | | | |
|------------|---------------|----------|-------------------------------|
| vál-il-a | ‘get dressed’ | inactive | [a...i] |
| polam-il-a | ‘stoop’ | visible | [o...a...i], not *[o...a...e] |

As illustrated by the Chewa patterns (and parallel behaviour by Old Norwegian neutral $\text{æ}-\varnothing$), a segment despite being inactive/inert may nevertheless be visible, halting harmony from spreading further downstream. Neutral blocking patterns like these are not predicted by either of the grammatical or representational tools we considered above. Using either minimal-pairing relativisation or feature underspecification by narrowing feature scope, both approaches directly link phonological activity/visibility via phonological contrastivity (20). Neutral blocking languages like Chewa or Old Norwegian which display simultaneously visible but inactive segments are therefore a common problem.

(20) Harmony visibility and activity according to Contrastive Hierarchy Theory and Nevins’ (2010) contrastive-relativisation

	visible	invisible
active	<i>harmonic trigger/target</i> (specified/non-relativised)	
inactive	<i>neutral blocking</i> ??	<i>transparent segments</i> (underspecified/relativised)

The ternary typology of non-alternating segments in harmony languages is illustrated above in (20). Non-/relativisation in Nevins’ (2010) Search-and-Copy approach and under-/specification in Contrastive Hierarchy Theory predict only two types of harmony neutrality, ruling out inactive but visible neutral blocking segments.

1.3.3 The usual way out

In phonology, the typical response to theoretical undergeneration as in (20) is to add something. One common approach is the use of adjacency parameters ([Odden](#)

1994). Specifically, neutral blocking can be explained away under both accounts using an additional constraint or parameter limiting the distance over which harmony can apply in any given language. For instance, we could analyse /a/ as being identical in Ndendeule and Chewa – i.e. a transparent segment, underspecified for [high] or excluded by contrastive relativisation. The difference between these two languages may be construed as a difference in harmony locality restrictions. Though /a/ is harmonically neutral in both Ndendeule and Chewa, harmony can skip syllables in Ndendeule (19b), applying at a distance two syllables away (e.g. [koβal-el-a] ‘stumble’-APPL.-FV.) while it cannot in Chewa (19c) where harmony only spreads between immediately adjacent syllables (e.g. [polam-il-a], *[polam-el-a] ‘stoop’-APPL.-FV.). In other words, we can maintain the binary distinction in featural under/specification or contrastive-relativisation in (20), attributing strictly local vs. long-distance harmony differences to orthogonal constraints on harmony locality. This is explicitly expressed in Nevins’ framework, which assumes an additional parameter which limits permitted distances between harmony triggers and targets, abbreviated as $\beta = 1/2$ syllables below. Contrastive Hierarchy Theory would have to incorporate a similar grammatical limitation.

(21) **Ndendeule height harmony:**

Height-Harmonise: $\beta = 2$ syllables, F = [contrastive: (±)high]

(22) **Chewa height harmony:**

Height-Harmonise: $\beta = 1$ syllable, F = [contrastive: (±)high]

Though this account is grammatically accurate for the above Bantu languages, this approach to neutral blocking as transparency-plus-something comes at a cost. Treating the exceptional visibility of otherwise excluded segments like Chewa /a/ as the result of some additional grammatical mechanism is ad hoc, introduces a lot of redundancy in the system, and does not always make the right predictions. For example, neutral blocking as transparency-plus-distance-restrictions as in (22) does not predict languages which display both local and non-local forms of harmony neutrality simultaneously. A famous example of a such language where local neutral blocking co-occurs with non-local forms of harmony transparency is Khalkha or Halh (Mongolian; Svantesson 1985, Svantesson et al. 2008). Khalkha displays a form of perseveratory or progressive labial harmony, as illustrated using direct past and instrumental suffixes in (23).¹²

(23) **Khalkha (Mongolian) rounding harmony**

NON-ROUND	<u>xe</u> ɛɣ-ɣe	‘decorate’-DIR-PAST
	et-eer	‘item’-INST
ROUND	<u>o</u> g-ɣo	‘give’-DIR-PAST
	ot-oor	‘feathers’-INST

Khalkha features two distinct neutral classes: /i/ which lacks a corresponding round */y/ counterpart and /u/ which lacks a corresponding non-round */w/. As illustrated by

¹²Khalkha also displays a form of tongue root harmony, which is not immediately relevant to the discussion at hand. For simplicity’s sake, I consider only advanced (ATR) vowels here. For a complete analysis of Khalkha vowel sequences, see section A.14.

the patterns in (24), both vowels take (the default) non-round [-e, -ɛe, -eer] suffixes. In Khalkha, /u/ is like /a/ in Chewa. Despite being articulatorily/acoustically round, it does not trigger labial harmony.

(24) **Khalkha neutral /i, u/ pattern with non-round vowels**

- | | | | |
|----|------------------|------------------|-------------------|
| a. | š <i>ii</i> t-ɛe | | ‘decide’-DIR-PAST |
| b. | i <i>t</i> -eer | | ‘strength’-INST |
| c. | t <i>uu</i> ɛ-ɛe | *t <i>uu</i> ɛ-ɔ | ‘jump’-DIR-PAST |
| d. | u <i>t</i> -eer | *u <i>t</i> -oor | ‘day’-INST |

The patterns in (25) below illustrate that /i/ is neither active nor visible to Khalkha rounding harmony. In word-medial positions, /i/ can co-occur with both non-round and round vowels: e.g. [t*ee*ɛ-ig-e] and [p*oor*-ig-o], not *[p*oor*-ig-e]. This is the same pattern we observed in Ndendeule /a/-patterns – suggesting that Khalkha, like Ndendeule, only applies labial harmony to harmonically paired segments. That is, in Nevinsonian terms, an example of relativised harmony operation, or in contrastive hierarchy terms, a language where the harmony feature has narrower scope than some asymmetric, orthogonal /i/-feature. The patterns in (24, 25) also indicate that Khalkha (like Ndendeule) can apply at long distances, resulting in transparently skipped unpaired-/i/. Khalkha must therefore assume no distance restriction on labial harmony, and this predicts that any labially neutral segment should be transparent in Khalkha.

(25) **Khalkha /i/-transparency**

- | | | | |
|----|----------------------|------------------|--|
| a. | t <i>ee</i> ɛ-ig-e | ‘gown’-ACC-RFL | |
| b. | p <i>oor</i> -ig-o | ‘kidney’-ACC-RFL | *p <i>oor</i> -ig-e, *p <i>oor</i> -yg-o |
| c. | ch <i>aa</i> s-ig-aa | ‘paper’-ACC-REFL | |
| d. | xɔɔɛ-ig-ɔ | ‘food’-ACC-REFL | *xɔɔɛ-ig-a, *xɔɔɛ-yg-ɔ |

This prediction is violated by /u/ in Khalkha. In word-medial positions, /u/ results in neutral blocking of rounding harmony patterns just like how low /a/ neutrally blocks vowel lowering in Chewa despite being articulatorily/acoustically low (7). Regardless of how many round vowels occur further downstream, /u/ neutrally blocks labial harmony: e.g. [tʰɔsɔɛ-*u*ɛ-ɛe], not *[tʰɔsɔɛ-*u*ɛ-ɔ]. This is illustrated in (26) using neutral blocking causative and otherwise harmonising direct past suffixes.

(26) **Khalkha neutral blocking /u/**

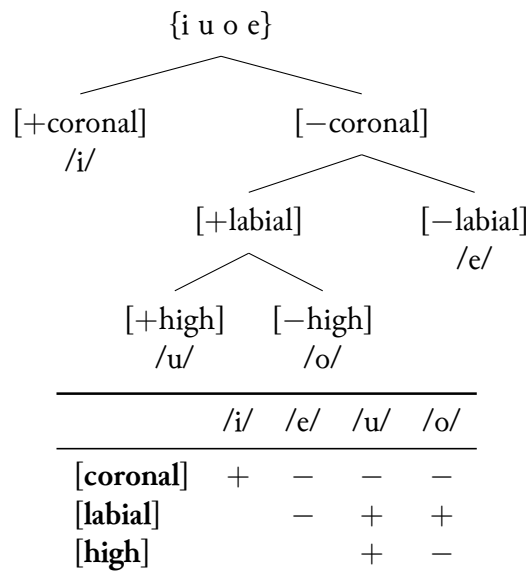
- | | | | |
|-----------------|---------------------|----------------------|--------------------------|
| NON-TARGET | i <i>t</i> -uɛ-ɛe | *i <i>t</i> -wɛ-ɛe | ‘eat’-CAUS-DIR-PAST |
| | x <i>ee</i> ɛ-uɛ-ɛe | *x <i>ee</i> ɛ-wɛ-ɛe | ‘decorate’-CAUS-DIR-PAST |
| NON-TRANSPARENT | o <i>g</i> -uɛ-ɛe | *o <i>g</i> -uɛ-ɔ | ‘give’-CAUS-DIR-PAST |
| | tʰɔsɔɛ-uɛ-ɛe | *tʰɔsɔɛ-uɛ-ɔ | ‘imagine’-CAUS-DIR-PAST |

Similar to Chewa /a/, Khalkha /u/ is a visible non-trigger, non-target, and neutral blocker of vowel harmony. In other words, Khalkha displays both local and non-local forms of harmony neutrality simultaneously – transparent /i/ but blocking /u/. Neutral blocking in this case cannot be reduced to transparency-plus-distance-restrictions. It must be transparency-plus-something-else if we want to maintain the link between

phonological activity and visibility posited by Nevins (2010) and proponents of Contrastive Hierarchy Theory. Restricting harmony to all the right places in intricate harmony systems like Khalkha quickly leads to an explosion of the necessary theoretical tool-kit. In order to avoid getting lost in the details, I will not pursue the analysis of Khalkha in detail here.

In the way of a brief summary, previous analyses of Khalkha using Nevins' Search-and-Copy method and Contrastive Hierarchy Theory are forced to treat /u/ but not /i/ as visible to [labial]-harmony. For instance, this is done using contrastive hierarchies by ordering some /i/-feature (e.g. [coronal]) outside the scope of [labial] but some /u/- feature (e.g. [high]) within [labial] as in Fig. 1.5.¹³ Finally, we require some kind of parasitic-like restriction on trigger/target similarity for vowel height. That is, [labial] harmony in Khalkha can only apply between height similar non-high /e, o/ to the exclusion of [+high] /u/ (24–26). This would be another example of parasitic harmony, similar to the restrictions limiting harmonic lowering among round vowels in Bantu height harmony. In essence, /i/ is transparent like /a/ in Ndendeule or /i, e/ in Finnish, but /u/ is a visible [+labial] blocker which nevertheless is excluded from the trigger set by an orthogonal limitation on height-similarity; cf. Drescher (2009, p. 183); Nevins (2010, pp. 136–39); Godfrey (2012); Ko (2013).

Figure 1.5: Khalkha contrastive feature specifications by harmony visibility



In summary, Khalkha demonstrates a ternary distinction between active/visible harmonising /e, o/, inactive/visible neutral blocking /u/, and inactive/invisible transparent /i/ in one and the same language. Attempting to fit these distinct harmony behaviours into the two broad categories outlined in (20) requires substantially complex while also weakly motivated additional grammatical machinery, regardless of the original approach. Crucially, this theoretical fragmentation means there is no single pathway which leads to neutral blocking. For instance, we have already seen competing neutral blocking as

¹³This contrastive feature hierarchy only displays advanced or ATR vowels /i, u, e, o/. For a full contrastive feature hierarchy including both labial/non-labial and tongue root contrasts, see section A.14.

transparency + distance restrictions in Chewa but neutral blocking as non-transparency + parasitic trigger–target height similarity in Khalkha.

This unfortunately limits the theoretical insights such frameworks can provide for the study of Old Norwegian neutral blocking since both frameworks admit multiple analyses of the same patterns in any given language. For example, we previously analysed Chewa /a/-neutral blocking as the result of being excluded from the active/visible set (either by contrastive relativisation or by [high]-underspecification) plus an orthogonal parameter limiting Chewa harmony to adjacent syllables – e.g. strictly local [wɛlam-il-a] and not long-distance *[wɛlam-el-a] ‘bend’-APPL.-FV. But judging from the Khalkha neutral blocking patterns above, things could be otherwise. We could apply the same neutral-blocking-as-parasitism analysis from Khalkha to Chewa.

We could assume the set of active/visible harmony triggers in Chewa is exactly like Mbunda (/a/ being specified [–high]) – making /a/ visible to height harmony. In this case, Chewa [high]-harmony must be orthogonally limited by trigger–target similarity with respect to [low], such that [high]-harmony can only apply between height-similar [–low] /e, i/ to the exclusion of [+low] /a/. Under this account, /a/ is specified [–high] and would in theory trigger harmonic lowering in /vál-il-a/ ‘get dressed’, except it cannot because Chewa height harmony is contingent on trigger/target agreement for [low] and /a/ and /i/ are [±low]-mismatched. This is abbreviated in (27) as a similarity-parameter requiring low agreement ($R = (\pm)\text{low}$). In this way, the analysis of /u/ in Khalkha and /a/ in Chewa can be unified. They are predicted to be *visible* (bearing a harmony feature) but *inactive* since they fail to agree with harmony targets in their orthogonal feature specifications.

(27) **Alternative Chewa height harmony as [low]-parasitism:**

Height-Harmonise: $F = [(\pm)\text{high} \ \& \ R = (\pm)\text{low}]$

This latter analysis of Chewa neutral blocking as parasitism is equivalent to neutral blocking as transparency-plus-distance-restrictions. Both harmony definitions in (22) and (27) require some orthogonal parameter – either on trigger–target distance or on trigger–target similarity with respect to [low]. Both approaches work out computationally the same way. In fact, it might be that some Chewa speakers assume the grammar in (22) while others assume the grammar in (27) since the end result is equivalent. We have, in other words, a duplication problem. If these are indeed the building blocks of harmony systems – if harmony segments are strictly either visible/active or invisible/inactive and any other patterns are the result of a myriad of orthogonal restrictions on harmony grammars – then we must admit that we cannot know for sure what causes neutral blocking in any given language.

1.4 The need for a new model

It is not obvious to me that we are on the right track here. Ideally, where possible, our theories should make explicit predictions. Treating typologically common neutral blocking as in Old Norwegian, Chewa, and Khalkha as the multifaceted, indirect result of various unrelated constraints on harmony processes and/or representations is too permissive and risks overgeneration. Second, this approach to neutral blocking requires

more grammatical machinery than other forms of neutral harmony, which are often ad hoc and weakly motivated; see [Downing & Mtenje \(2017, pp. 70–89\)](#) for a critique of common analyses. This potentially makes the wrong typological predictions.

Regardless of which analysis we assume – Chewa neutral blocking as locality restrictions (2.2) or via limitations on trigger–target similarity (2.7) – both accounts require a more complex harmony grammar than either corresponding Mbunda or Ndendeule height harmony, which require neither constraints on trigger–target distance or similarity. Given this fact, we might expect Chewa to be the exceptional pattern among Bantu height harmony languages, but the opposite is true. Chewa represents the canonical pattern in Bantu height harmony, attested in hundreds of languages across the dialectal spectrum. By comparison, only a handful of areally related, mostly K/R-zone 5V-languages display fully harmonic systems with harmonic low vowels like Mbunda ([Hyman 1999, p. 242](#)). Moreover, there are only two languages I am aware of which reportedly have low vowel transparency: Ndendeule which we have explored here and Gungu (J.10) discussed further in sections 2.2.1 and 3.1.3. We must of course be careful in attributing too much weight to typological asymmetries in genetically related languages such as these Bantu varieties since in principle these asymmetries could be the result of common inheritance. However, very conservatively put, neutral blocking in Bantu height harmony is so widespread and diachronically stable, it is in the very least surprising if neutral blocking patterns really require more specific or more complex grammatical architecture than other forms of harmony neutrality.

Moreover, the contexts in which neutral blocking occurs across languages are not obviously significantly different from other forms of neutral harmony. For instance, neutral blocking is correlated with asymmetric inventory shape and is a common optional alternative to other forms of blocking and transparency. As we have seen in the three Bantu languages above, harmonic blocking /a/ in Mbunda ([Gowlett 1970](#)) can be swapped out for transparent /a/ in Ndendeule (Deo Ngonyani p.c.; cf. [Ngonyani 2004](#)) and neutral blocking /a/ in Chewa ([Downing & Mtenje 2017](#)). There are many non-height harmony parallels as well. For example, among 7V-tongue root harmony systems, /a/ is a harmonic blocker in Yoruba ([Ọla Orie 2001, 2003](#)), transparent in Dengese (C.81; cf. [Hulstaert & Goemaere 1984, Leitch 1996](#)), and neutral blocking in Nkundo (C.60; [Hulstaert 1961, Leitch 1996](#)) or Kikuyu (E.51; [Armstrong 1940, Peng 2000](#)). Even among closely related dialects, we see the same kind of variation: for example, /i, u/ are harmonising in the Ekiti variety of Yoruba, transparent in Ifẹ Yoruba, but neutral blocking in Standard Yoruba ([Ọla Orie 2001, 2003](#)).

In summary, explicit appeals to feature contrastivity in harmony frameworks fail to provide a unified account of neutral harmony. In their current form, these theories are simultaneously too restrictive and too permissive. Both approaches disallow typologically common visible but inactive neutral blockers and attempts to accommodate them require ad hoc and weakly motivated grammatical machinery which yet fails to produce a single pathway leading to neutral blocking. Clearly, there is a significant link between phonological contrastivity and harmony variation, but we have not found it yet.

1.5 Aims of this thesis

Accounting for the problems I have outlined above in Bantu and structurally similar harmony languages is a classic phonology problem and serves as ‘a standard test case for theories of the representation and assimilation of vowel features’ (Downing & Mtenje 2017, p. 75). These patterns raise a number of important theoretical and typological questions. For example, what do segments which display contradictory patterning to their articulatory/acoustic substance reveal about the nature and representation of phonological features and feature classes? What motivates harmony vs. neutral harmony? What is the relationship between inventory asymmetries and the ternary in/active–in/visible behaviour of neutral segments? In addition to these general questions, an accurate treatment of Old Norwegian segmental phonology introduces additional philological and historical phonological challenges. For instance, how do we collect and ensure a sizeable corpus of phonologically reliable data from 700–800 year old manuscripts? How do we establish the status of a given sound pattern in historical, non-normalised textual material? How do we distinguish between a scribe’s spoken language and orthographic conventions, copying interference, and other extra-linguistic factors? The problems posed by Old Norwegian, Chewa, Khalkha, and similar harmony patterns thus transcend many disciplines in the language sciences, and solving these issues stands to make substantial contributions to the phonological study of historical Norse dialects, in particular, and the theoretical and typological study of vowels and vowel harmony systems more broadly.

As indicated by its title, this thesis has two (too?) ambitious goals. First, building on the contrastive hierarchy architecture (drawing heavily on insights from particularly Iosad 2017a; D. C. Hall 2007; Mackenzie 2013, 2016; Dresher 2014, 2018), I present a modified, substance-free version of a Contrastive Hierarchy Theory which incorporates emergent features and feature-nodes. This novel approach to phonological representations, featural specifications, and contrastivity provides a unified and insightful treatment of the acquisition and representation of vowels and phonological classes, the patterning of harmony processes, and the motivations for typological asymmetries in the shape and patterning of languages’ vowels. Building on a broad cross-linguistic survey of height, tongue root, backness, and rounding harmony systems, I have demonstrated that this version of Contrastive Hierarchy Theory is typologically accurate, predictive, and suitably constrained. The real value and test of a theory, however, is whether it can provide new insights into questions which otherwise have resisted explanation. Old Norwegian vowel harmony provides such an example.

Despite more than 150 years of philological and linguistic research, the basic problems of Old Norwegian vowels and vowel harmony have defied a coherent analysis.¹⁴ To contribute to this subject, Pavel Iosad and I have developed methods for the automated collection and annotation of Old Norwegian vowel patterns using *Medieval Nordic Text Archive* digital transcriptions. Using these methods, I provide a sizeable corpus study of Old Norwegian vowel patterns in a variety of 13th-century manuscripts, totalling around 279,800 words.¹⁵ This investigation has provided new data and identified many crucial,

¹⁴See Sandstedt (2017) and Myrvoll (2014) for detailed surveys of previous philological approaches and problems.

¹⁵This data set, filtered and phonologically-annotated for the 600 most frequent lexemes in the corpus, is accessible online at <http://dx.doi.org/10.17613/gj6n-js33>.

previously overlooked patterns which take us a long way in understanding the nature of Old Norwegian vowel harmony. However, there are ultimately limits to what philology in a vacuum can tell us. The same philological/orthographic generalisations often admit a wide variety of analyses; see for example the great range of competing interpretations of the phonological representation of $\text{æ}-\text{ø}$ vowels in Hagland (1978a), Rajić (1980), Grønvik (1998), S. Johnsen (2003), Sandstedt (2017), among others. Given the nature of the material, these analyses can be neither empirically confirmed or falsified, nor do we have tangible criteria by which to compare them. Using Old Norwegian vowels as a test case, I show how the contrastive hierarchy approach provides explicit heuristics based on typologically established principles for identifying a language's active phonological features, specifications, and sound classes from ordinary phonological generalisations. Applying these methods to Old Norwegian harmony patterns, we are able to place Old Norwegian in its appropriate typological context for the first time, which provides insights into its phonological features, vowel classes, and harmony patterns which we would not be able to recover using philological evidence alone.

Using this combination of detailed corpus methods and broad theoretical and typological insights, this thesis aims to contribute both to the explanation of Old Norwegian philology/phonology, in particular, and of human language, in general. This thesis will therefore be of interest to researchers across a wide range of fields, and I have attempted to write the thesis accordingly. Generally, this thesis should be accessible both to philologists with limited theoretical training and linguists with little background in Norse languages/linguistics. To that end, the theoretical and empirical matters are treated in distinct parts to make each subject easily available to the right audiences. My version of Contrastive Hierarchy Theory and its application to a wide range of Niger-Congo and Turkic languages is presented in detail in chapters 2/3. These can be read independently and in the absence of any background in Norse philology. At the same time, I imagine not all philologists will be equally concerned with the theoretical matters. To this end, the corpus study's methodology and a fairly atheoretical investigation of the data are provided in chapters 4/5. The two areas are combined in the final analysis of Old Norwegian and summary of results in chapter 6. The thesis' main conclusions and a practical summary along with useful schemata for applying contrastive hierarchy analyses are provided in chapter 7. Finally, I provide an appendix with full vocalic contrastive feature hierarchies for each harmony language cited in this thesis with corresponding harmony generalisations for comparison.

I believe this project and the problems it addresses demonstrates the value of philology in phonology and vice versa when tackling problems which naturally encompass both disciplines. It is my hope that this approach aids the reader in drawing new insights on similar new and old philological and phonological problems.

Part II

Theoretical matters

Chapter 2

Features and the contrastive hierarchy

The goal of phonology is the construction of a theory in which cross-linguistically common and well-established processes emerge from very simple combinations of the descriptive parameters of the model...[P]rimary emphasis should be placed on studying phonological representations rather than rules. Simply put, if the representations are right, then the rules will follow.

McCarthy (1988, p. 84)

The broad theoretical aim of this thesis is to explain the role of phonological patterning in determining the featural content of phonological relations and therewith the size and shape of sound inventories. I argue the major locus of variation in phonology is the result of language-particular differences in the representation of subsegmental structure. In this chapter, I outline the framework's core representational assumptions and demonstrate that the theory is grounded in typologically valid principles via an exploration of the role of representations in a wide variety of vowel harmony systems.

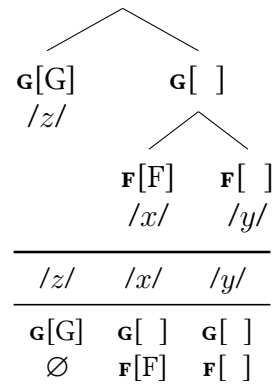
2.1 Harmony as evidence for representations

Harmony processes very generally defined involve the correspondence between all bearers and potential bearers of some harmonising phonological feature. Exceptions in harmony patterns such as neutral harmony (e.g. transparency, blocking, etc.) or asymmetric trigger and target classes (e.g. in so-called 'parasitic' harmony systems) are strongly correlated with asymmetric inventory shape and/or phonological contrastivity more generally (Kiparsky & Pajusalu 2006). For this reason, harmony systems are arguably the most valuable naturally occurring phenomena for investigating the nature and limits of phonological representations on phonological patterning and provide this thesis' main empirical focus.

2.1.1 Representational overview

Harmony systems display three traits which serve as the primary diagnostics for this thesis' representational framework. Specifically, harmony systems display 1) marked/unmarked asymmetries, which evidence feature privativity (e.g. active triggers vs. inert targets, harmonic vs. neutral blocking, etc.). 2) Harmony systems exhibit feature class and subclass relationships, which evidence hierarchical organisation of phonological features (e.g. transparency vs. blocking asymmetries, spreading of whole groups of features, etc.). 3) Harmony languages feature significant cross-linguistic variation in the content and relation of feature classes, evidencing emergent features / non-innate feature geometry. To capture these insights, I adopt a version of Contrastive Hierarchy Theory or Modified Contrastive Specification (Dresher, Piggott & Rice 1994; Dresher 2003, 2009; Iosad 2017a) which incorporates emergent, substance-free privative features and feature-nodes. A simple abstract example of the kinds of representations produced by this version of Contrastive Hierarchy Theory is provided in Fig. 2.1, assuming two features [F] and [G] which do not co-occur, producing three segments /x, y, z/. As illustrated by Fig. 2.1, this framework assumes nesting relationships between a language's featural contrasts which depend on feature-specific nodes **F** and **G**. For example, [F]-contrasts in Fig. 2.1 are a sub-distinction of non-G segments.

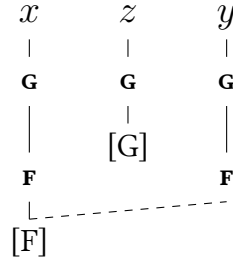
Figure 2.1: Classes and sub-classes in a privative contrastive feature hierarchy



Contrastivity for the feature [F] is defined by bearing an **F** feature-node. In other words, this node distinguishes the (contrastive) set of segments /x, y/ from non-contrastive underspecified (**F**-node-less) /z/ segments. Sub-inventories of the contrastive set /x, y/ are distinguished by feature specifications: the marked or dominant sub-inventory /x/ is specified [F] while the unmarked or recessive (non-F) /y/ sub-inventory is non-specified for [F]. This hierarchical organisation thus produces the ternary contrast in feature specifications required to account for the ternary distinction in harmony segments' phonological in/activity and in/visibility observed in section 1.3.2. These are specifically 1) contrastively specified **F**[F] /x/ (e.g. visible and active harmony triggers/harmonic blockers), 2) contrastively non-specified **F**[] /y/ (e.g. visible but inactive harmony targets/neutral blockers), and 3) non-contrastive underspecified ∅ /z/ (e.g. invisible and inactive transparent segments). A version of Contrastive Hierarchy Theory which incorporates privative features and feature-specific nodes thus provides the precise architecture required to account for the basic typology of harmony behaviour types.

Following the representations in Fig. 2.1, harmony locality can be accounted for in a traditional way by assuming strictly local feature spreading between [F]-specified and non-specified segments. Feature-nodes provide the landing sites for harmonic spreading, as demonstrated by the autosegmental representations in Fig. 2.2 (cf. Avery & Rice 1989, Odden 1994). Fig. 2.2 illustrates feature spreading between harmony triggers and targets across transparent or non-contrastive, underspecified segments. Note that the feature specifications and order of feature nodes in Fig. 2.2 are defined by the specifications and order of featural divisions in Fig. 2.1.

Figure 2.2: Local [F]-spreading between contrastively specified triggers and non-specified targets



The further grammatical implementation of the contrastive hierarchy architecture in harmony processes is the focus of the following chapter 3. In the current chapter, I explore the basic building blocks of this approach; that is, how the language learner acquires and defines the kinds of representations outlined above. For clarity of presentation, I illustrate the role of representations in phonological patterning piecemeal from narrower to broader levels, starting with the nature of individual phonological features which combine to build segmental representations. I then explore how individual segments further combine to make up phonological classes, ultimately producing full sound inventories over which harmony generalisations are made.

Specifically, building on the assumptions of privative and emergent feature theories outlined in section 2.2, I demonstrate in section 2.3 how language learners generalise the active set of phonological features and feature co-occurrence restrictions in their language based on observed phonological in/activity in segmental phonological processes. As outlined above, I specify segmental representations according to the contrastive hierarchy approach, the main organising principles of which are outlined in section 2.3.2. In this framework, phonological features are specified on segments according to a privative version of the Successive Division Algorithm (SDA; Dresher 2005, 2009; D. C. Hall 2007) informed by phonological in/visibility (e.g. harmony transparency/blocking). These components taken together produce an explicit and very limited theory of phonological representations, which recapitulates many of the important insights of earlier forms of feature geometry while remaining consistent with a fully emergent and substance-free approach to phonological features, as illustrated in section 2.4. Finally, a concise review of these representational components is provided in section 2.5.

2.2 Nature of phonological features

2.2.1 Privativity

In harmony systems, it is widely recognised that one value of the harmony feature (that is, in binary terms [+F] or [−F]) functions as ‘dominant’ or ‘active’ while the other is ‘recessive’ or ‘inert’ (Baković 2000, Casali 2003, van der Hulst & van de Weijer 1995). This is well-established in so-called dominant/recessive tongue root harmony systems (Casali 2003, 2016). In dominant/recessive harmony languages, the presence of the marked/dominant harmony value anywhere in the harmony domain leads to bidirectional harmony.

For example, Gungu or Lugungu (J.10), a Bantu language spoken in the Buliisa, Hoima, and Masindi districts of Uganda (Kutsch Lojenga 1999, Diprose 2007), displays tongue root harmony with stems which determine the realisation of harmonising affixes (e.g. the applicative suffix and class prefixes), but there are also suffixes which determine the realisation of stems, such as the non-alternating [ATR] agentive suffix /-i/ (28). These patterns are analysable as dominant/recessive; ATR vowels are dominant resulting in [ATR] harmony throughout the word (e.g. /ku-luk-ɪr-a/ → [ku-luk-ɪr-a]) while RTR vowels are recessive ([ATR]-non-specified) wherever they occur: e.g. /mu-lim-i/ → [mu-lim-i]. The low vowel /a/ in Gungu is generally interpreted as lacking an underlying ATR counterpart */ə, ɐ/ and is neutral with respect to ATR harmony: RTR [ku-mal-ɪr-a] ‘finish’-APPL. but ATR [mu-ɲʷa:-i] ‘befriend’-AGENT.

(28) Dominant/recessive ATR harmony in Gungu

	UR of stem	Neutral suffix (infinitive/final V)	Harmonising suffix (applicative)	Dominant suffix (agentive)
RTR STEM	/-lim-/ ‘dig’	ku-lim-a	ku-lim-ɪr-a	mu-lim-i
ATR STEM	/-luk-/ ‘weave’	ku-luk-a	ku-luk-ɪr-a	mu-luk-i

Active/inert asymmetries are clearest in ‘dominant/recessive’ harmony systems like Gungu, but they are also detectable in just about every harmony language. It is only ambiguous in languages with completely symmetric sound inventories what the language-particular feature value asymmetry is; see, for example, Dëgëma, an endangered Atlantic-Congo (Edoid) language spoken in Nigeria, which features a ten vowel inventory with fully symmetric ATR/RTR contrasts and apparently no harmony neutrality of any kind (Kari 2007).

Matuumbi or Kimatuumbi (P.13), a language spoken in the area of Kipatimu in Kilwa District of Tanzania, south of the Rufiji river, demonstrates the alternative active/inert asymmetry to Gungu in positionally restricted (or ‘root-controlled’) left-to-right (perseveratory) RTR harmony – spreading only from root-initial to non-initial syllables (Odden 1996, 2003, 2015). In both Gungu and Matuumbi, /a/ is neutral/non-alternating and underspecified for the harmony feature. Since /a/ does not trigger any harmony alternations, this vowel is an indicator of underlying (default/unmarked) feature values. In Gungu /a/ patterns with retracted vowels in unmarked contexts – e.g. with the applicative suffix in [ku-mal-ɪr-a], *[ku-mal-ɪr-a] – but in Matuumbi neutral /a/

takes advanced suffixes – e.g. [tʃáag-ilw-a], *[tʃáag-ilw-a] (29). In other words, the active/dominant feature is tongue root advancing [ATR] in Gungu but retracting [RTR] in Matuumbi. Stems do not alternate in Matuumbi, and harmony spreads strictly from roots to suffixes (29).

(29) **Active RTR–inert ATR perseveratory harmony in Matuumbi**

	Infin.	Passive infin.	Causative infin.	
ATR STEM	/ín-a/	ín-ilw-a	ín-ij-a	‘dance’
	/kún-a/	kún-ilw-a	kún-ij-a	‘grate coconut’
RTR STEM	/twúk-a/	twúk-ilw-a	twúk-ij-a	‘lift a load’
	/úug-a/	úug-ilw-a	úug-ij-a	‘bathe’
NEUTRAL STEM	/tʃáag-a/	tʃáag-ilw-a	tʃáag-ij-a	‘grind’
		*tʃáag-ilw-a	*tʃáag-ij-a	

Harmony value asymmetries like those above are often overlooked outside tongue root harmony but are in fact well-established in height harmony systems as well. Vowel height harmony languages are either dominant lowering (e.g. canonical Bantu height harmony, [Odden 2015](#); Old Norwegian, [Sandstedt 2017](#)) or dominant raising (e.g. Pasiego Montañes Spanish, [Vago 1988](#); Buchan Scots, [Youssef 2010](#)). As shown in (30), for example, underlying unstressed high vowels in Old Norwegian lower following mid vowels – e.g. /drep-inn/ → [‘drep-enn] – but the opposite never occurs; underlying mid vowels never raise in correspondence with high vowels: e.g. /‘i:s-enn/ → [‘i:s-enn], *[‘i:s-inn].

(30) **Lowering non-high triggers – inert high targets in Old Norwegian**

- a. Lowering of /-inn/ PRET.PART.
- | | | | |
|-----------|----------|----------|----------|
| drep-enn | ‘kill’ | orð-enn | ‘become’ |
| svi:k-inn | ‘betray’ | bund-inn | ‘bind’ |
- b. Non-raising of /-enn/ DEFINITE
- | | | | |
|----------|----------|------------|--------|
| o:s-enn | ‘outlet’ | konong-enn | ‘king’ |
| i:s-enn | ‘ice’ | hug-enn | ‘mind’ |
| *i:s-inn | | *hug-inn | |

The alternative asymmetry in raising harmony systems is displayed in (31) by the Pasiego dialect of Montañes Spanish ([Vago 1988](#)). Like Old Norwegian, raising harmony in Pasiego Montañes Spanish spreads from stressed syllables to unstressed syllables. Non-high roots like in *koxér* ‘to take’ undergo raising (e.g. /koxe‘r-i:s/ → [kuxi‘r-i:s], *[koxe‘r-i:s]) whereas underlyingly specified high roots like *sintír* ‘to feel’ do not lower (e.g. /sinti‘r-e/ → [sinti‘r-e], *[sente‘re]).

(31) **Inert non-high triggers in Pasiego Montañes Spanish (Vago 1988)**a. Raising of /e, o/ – *koxér* ‘take’

koxe're I.SG.FUT.

kuxi'ri:s 2.PL.FUT.

b. Non-lowering /i, u/ – *sintír* ‘feel’

sinti're ‘feel’-I.SG.FUT. *senteré

sinti'ri:s ‘feel’-2.PL.FUT.

These active/inert asymmetries provide strong evidence that the basic currency of phonological operations and segmental representations are privative or monovalent phonological features: e.g. [open] or [close] rather than [\pm high]. Differences in active/inert asymmetries across languages can be construed as variation in relative markedness. I attribute a language’s marked or unmarked values to the presence or absence of a feature specification (i.e. marked/dominant [F] vs. unmarked/recessive []). Unmarked patterns such as targets and non-triggers in harmony processes or the outcomes of neutralisation in weak positions follow from the absence or loss of phonological structure, corresponding to the non-specification or deletion of a feature [F]. /e, o/ are active/marked feature donors in Old Norwegian while /i, u/ are inert/unmarked recipients, suggesting the harmony feature and markedness relation must be defined by some lowering [open] feature. In Pasiego Montañes Spanish, the opposite is true: /i, u/ are active/marked feature donors while /e, o/ are inert/unmarked targets, suggesting the harmony feature must be some raising [close] or [high] feature. Privative features thus provide the right kind of structure to capture the empirical facts.

As I outline throughout this and remaining chapters, these feature asymmetries are not only present in differences in harmony trigger/target activity–inertness but also play an important role in our understanding of unmarked/neutral behaviours in general, such as inequalities in neutralisation, blocking, parasitic harmony, and so on. Under binary feature theories, such asymmetries must be explained away by additional marking statements/prohibitions or redundancy rules for default/non-default or marked/unmarked binary values (e.g. Archangeli 1988; Calabrese 1995, 2005, Nevins 2010, Dresher 2014), but this additional machinery is unnecessary. Feature inequalities are everywhere as predicted by the under/specificational dichotomy inherent in privative features.

2.2.2 Emergence

I assume that the reference of phonological features is not innate but language-particular (cf. Mielke 2008, Iosad 2017a). Specifically, I argue that phonological features are *emergent* – that is, principally arbitrary categories posited by the language learner on the basis of language-specific contrasts and alternations – and *substance-free*, in the sense that features are abstract labels in principle independent of articulatory / acoustic substance. Though under these assumptions features are principally abstract, this does not mean that phonological features are ‘monolithic abstract symbols, completely unrelated to their phonetic substance’ (Cristà, Seidl & Francis 2011, p. 319); the relationship between phonological features and sound patterns is simply explained in a different way.

In innate feature theories (e.g. Jakobson, Fant & Halle 1951; Chomsky & Halle 1968; Clements & Hume 1995) phonological features are envisioned as universal entities specified in Universal Grammar which directly relate to acoustic or articulatory correlates, thereby limiting the ontology of possible and impossible phonological patterns in a predictable way. In this view it follows that recurring segment classes and phonological patterns are an effect of universal features. In emergent and substance-free feature theories, on the other hand, the relationship between phonological features and phonological patterns is reversed; features are generalised as needed by the phonological component in correspondence to phonological patterning which is shaped by a multitude of external factors – articulatory and perceptual mechanics among them.

Conceptually, this approach thus does not require us to banish substance from phonology altogether, and I follow Cowper & D. C. Hall (2013) and D. C. Hall (2014) in assuming that the acquisition/generalisation of phonological features is informed by identifying contrasts: i.e. contrasts in lexical meaning, contrasts in phonetic realisation, and contrasts in phonological behaviour. Thus, while phonological features are principally independent of substance insofar as they are not defined by articulatory / acoustic correlates, features are nevertheless ‘indirectly related to their phonetic correlates via the phonetically driven sound changes or analogical changes that produced the phonological patterns they refer to’ (Mielke 2008, p. 101). From this perspective, recurring segment / feature classes are the reflex of recurring phonological patterns and contrasts shaped by common factors in the physics and biology of human language. Both innate and emergent feature theories thus predict recurring ‘natural’ classes, but emergent feature theories ‘account for the fact that phonetics does not determine phonological destiny’ (D. C. Hall 2014, p. 11).¹

For our present purposes in historical phonological research, emergent feature theory provides an important heuristic for interpreting historical phonological representations. For Old Norwegian, for example, there is a long philological tradition of internal and comparative reconstruction, metrical studies, and now recent grapho-phonological corpus studies (see the corpus chapters 4–5 and Robert Paulsen’s forthcoming thesis). From this work, we have a detailed understanding of the number of distinctive segments and their phonological behaviour in processes such as vowel harmony and umlaut. Nevertheless, each vowel’s feature specifications and intersegmental relations are still matters of linguistic interpretation. In other words, we know how many contrastive vocalic units there were and what their respective patterns were in categorical phonological processes like vowel harmony, but each vowel’s representation and phonological features are up for debate. Following innate feature theories, a segment’s phonological features

¹Emergent feature theories also predict languages which – given the right circumstances – will display segment classes which share common phonological properties (in distribution / alternations) but which lack common phonetic substance (i.e. synchronically ‘unnatural’ or ‘crazy’ classes). One posited example is found in Kolami (Dravidian) plural allomorphy where nouns ending in /t d ŋ r l i e a/ take [-l] but nouns ending in /p t k d g s v z m ŋ j/ take [-ul] (Mielke 2008, §6.3). Such exceptional cases should be carefully reviewed with appropriate skepticism (cf. D. C. Hall 2010), but to the extent that any such ‘unnatural’ classes exist, emergent feature theories are empirically more adequate. ‘If at least some phonological patterns are phonetically arbitrary, then the phonological computation must have some mechanism capable of generating such patterns’ (D. C. Hall 2014, p. 2; cf. Anderson 1981; Hale & Reiss 2000, 2008). For more detailed discussions of the typological implications of emergent feature theory, see Mielke (2008); Mielke, Magloughlin & Hume (2010); D. C. Hall (2010, 2014); and Iosad (2017a).

do not necessarily depend on their phonological behaviour, and it is therefore not to be expected that phonological representations will necessarily be recoverable from historical phonological patterns. Put another way, innate historical phonological representations – as defined by universal feature theories – are both difficult and potentially impossible to identify and falsify. In contrast, emergent feature theory's principal hypothesis that phonological features emerge over the acquisition of phonological patterns provides an explicit anchoring point. Where we have reliable documentation of historical phonological processes – such as consistent and accurate vowel harmonic alternations in historical writing – we have sufficient evidence for inferring active phonological features and feature specifications. If it is correct that features are not innate but must be extracted from the data, then with the right data we can posit the right phonological features; this is true whether it be a contemporary or historical language.

2.3 Building inventories and the Contrastivist Hypothesis

It is widely acknowledged that harmony is limited by lexical contrast insofar as asymmetries in sound classes commonly produce inert or non-alternating (neutral) segments (e.g. Demirdache 1988, Krämer 2003, Kiparsky & Pajusalu 2006, Nevins 2010, Drescher 2015, van der Hulst 2018). This relationship between phonological in/activity and contrastivity is captured by the Contrastivist Hypothesis which holds that 'the phonological component of a language L operates only on those features which are necessary to distinguish the phonemes of L from one another' (D. C. Hall 2007, p. 20). Put another way, a language's set of active phonological features and phonological contrasts are correlated, but this hypothesis raises a number of fundamental questions: e.g. where do the phonemes of L come from and how are features selected to distinguish them? In other words, if the set of features are delimited by phonemic contrasts, how do language learners first acquire their segment inventory in the absence of explicit featural distinctions, and once a contrast is acquired (e.g. /a/ vs. /i/) – where is the information encoded by which the contrast is defined (e.g. high/non-high, front/back, low/non-low, etc.)? As discussed by D. C. Hall & K. C. Hall (2016, p. 4), a complete learning algorithm consistent with the Contrastivist Hypothesis 'would need to elaborate what it takes to identify the presence of a phonemic contrast and how the learner selects the features to assign'. Building on the insights of emergent feature theory by which abstract features are assigned to contrasts as a reflection of phonological behaviour, I suggest the defining relationship between features and contrasts is better characterised the other way around. In particular, I propose that the sum of features define possible lexical contrasts rather than the sum of contrasts defining a possible set of features. Building from the bottom-up rather than the top-down (i.e. from features to segments rather than from segments to features), the acquisition of phonological features and definition of sound inventories can be formalised while maintaining the basic insights of the Contrastivist Hypothesis. First, a language's phonemic inventory may alternatively be defined by features using what we might call the Correlate Contrastivist Hypothesis (CCH), as specified in (32).

(32) **Correlate Contrastivist Hypothesis**

The phonemes of a language L are equal to the sum of features and feature

co-occurrence restrictions which are minimally necessary for the expression of phonological regularities in *L*.

In other words, the accurate generalisation/acquisition of phonological patterns and contrasts requires the language learner to posit some minimal set of features and feature co-occurrence restrictions in order to label/define contrasting sound classes. As a model of phonological acquisition, I adapt certain insights from Westergaard's (2009, 2013, 2014) model of micro-cues. The key principle is that language learners from early on are sensitive to fine linguistic distinctions, and in the course of language acquisition children generalise small pieces of abstract linguistic structures ('micro-cues') while parsing linguistic input – e.g. a cue for OV word order is generalised as $_{VP}[DP\ V]$. Originally developed as a generative approach to the acquisition of syntax, the concept of micro-cues can be extended to phonological acquisition.

From contrasts in salient phonetic properties, lexical meaning, and phonological behaviour (cf. Cristà, Seidl & Francis 2011), I assume language learners posit representational micro-cues in the form of emergent, privative features $[F]/[G]$ and prohibited/obligatory $*[F, G]/[F, G]$ feature co-occurrence restrictions. The sum of these micro-cues – that is, the set of features and permitted/obligatory feature combinations – define the language's permitted segment inventory. I assume a distinct representational micro-cue is assigned for any categorical distinction in lexical or word-level phonological contrasts or alternations. Unique feature specifications define separate segments, the surface realisation of which is determined by mechanisms of phonetic implementation.

In the way of an illustration, consider the abstract surface patterns in (33). Three representational micro-cues are minimally necessary for the accurate generalisation and acquisition of the patterns in (33). First, language learners must posit some feature $[F]$ to express $[F]$ vs. non- F $[a]$ vs. $[b]$ contrasts in (33ab). For the sake of argument, let us assume that $[a]$ and $[b]$ never co-occur, and the contrasts in (33ab) represent an active $[F]$ -correspondence/harmony process. How we label the feature is presently not important; crucially this feature defines separate alternating phonological classes – $/a/$ vs. $/b/$. The relevant marked/unmarked asymmetry is not evidenced in this small data set and is not important to the example at hand, but for the sake of clarity, let us assume that $/a/$ is marked $[F]$ and $/b/$ is unmarked (non- F). Second, when encountering $[c]$ vs. $[b]$ contrasts in (33bc), language learners must generalise a second feature $[G]$ to define $[G]$ vs. non- G $[c]$ vs. $[b]$ distinctions.

(33) **Generalising phonological micro-cues from segmental contrasts/alternations**

	Patterns	Surface generalisations	Micro-cue
a.	$[a...a...a]$	$[a]$ vs. $[b]$ ($[F]$ vs. non- F) contrasts/correspondence	$[F]$
b.	$[b...b...b]$		
c.	$[b...c...b]$	$[c]$ vs. $[b]$ ($[G]$ vs. non- G) contrasts	$[G]$
d.	$[a...c...a]$	$[c]$ vs. $*[d]$ ($[G]$ vs. $*[F, G]$) contrasts/correspondence	$*[F, G]$
e.	$*[a...d...a]$		

The combination of $[F]$ and $[G]$ features provides minimally a three-way distinction between $[F]$ $/a/$, $[G]$ $/c/$, and non- F /non- G $/b/$. Finally, assuming $/a/$ triggers $[F]$ -harmony (33a), the lack of a corresponding $[G]$ vs. $[F, G]$ $[c]$ vs. $*[d]$ contrasts and

harmony alternation in [F]-environments in (33c-e) evidences a prohibited *[F, G] co-occurrence micro-cue. In other words, [G] /c/ is neutral (non-alternating), displaying no participation in [F]-harmony, and therewith the lack of an [F]-harmony counterpart *[d]. Using just these three micro-cues – [F], [G], and *[F, G] – we can accurately describe all the relevant contrasts and alternations in the phonological patterns in (33). This limited collection of data illustrates how small sets of positive/negative evidence of contrasts and alternations provide explicit indications to learners of the existence or absence of contrast-defining features and feature co-occurrences.

These micro-cues accumulate over the course of language acquisition. The sum of the generalised micro-cues in (33) define the language's permitted segment inventory, as illustrated in (34). Here I assume representations are maximally parsimonious, where every unique feature specification, non-specification, and co-occurrence defines a separate segment. From this it follows that the set of active phonological features and segment inventory will correlate – as predicted by the original Contrastivist Hypothesis – but this is so because a language's inventory is defined by the features minimally required to express its phonological grammar, not because the set of phonological features is limited by its set of phonemes.

(34) **Segment inventory defined by [F], [G], and *[F, G] cues**

Micro-cues	Phonemes
[F]	/a/
[]	/b/
[G]	/c/
*[F, G]	*/d/

The key insight – as expressed by the CCH in (32) – is that phonological regularities in surface contrasts and alternations in *L* inform phonological representations. When parsing surface patterns as in (33), language learners posit representational cues in the form of features/feature co-occurrence restrictions, which accumulate in the course of language acquisition. The total sum of these representational cues in turn defines the size/shape of the phonemic inventory of *L* as in (34). Consistent with other contrastivist approaches, this method predicts that languages with similar phonological systems will display similar-looking phonological inventories because the two are closely linked. Building on these insights, I demonstrate in section 2.3.2 how the acquisition and specification of phonological features on segments can be formalised using a modified version of the Successive Division Algorithm (Dresher 2005, 2009; D. C. Hall 2007; Mackenzie 2013, 2016) which takes representational micro-cues as its input and returns a contrastively specified segment inventory as its output. This method recapitulates the basic insights of the Contrastivist Hypothesis but provides a much more explicit model of how it pairs with the emergence and acquisition of phonological features which combine to produce speech segments, feature classes, and whole inventories.

In its current form, my approach finds close parallels in Magnetic Grammar (van Oostendorp & D'Alessandro 2017, D'Alessandro & van Oostendorp 2018), which also treats languages as operating with two primitives: individual features and *forces* –

attracting \supset and repelling $*$ forces between features, which correspond to the obligatory and prohibited feature co-occurrence micro-cues above. These may be represented as follows: $F, F\supset G, G^*H$ – where F, G , and H are features; F is specified as attracting G (corresponding to an obligatory $[F, G]$ feature co-occurrence cue); and G is specified as repelling H (corresponding to a prohibited $*[G, H]$ co-occurrence cue). In both frameworks, language acquisition involves the learning of individual features and their attracting/repelling relations. In both approaches, the locus of language variation is seen as variation in the acquired set of active features/forces and their hierarchical arrangement, as explored in greater detail in the following sections.

To provide a fuller illustration of my acquisition algorithm in practice, in the following section I will make use of some data from Yoruba, an Atlantic-Congo language spoken in Nigeria, Benin, and a number of other West African countries (Awobuluyi 1967, Bamgbose 1967, Archangeli & Pulleyblank 1989, van der Hulst 2012). Yoruba displays an illustrative example of microvariation in vowel contrasts / harmony alternations and has therefore figured prominently in studies on vowel harmony variation (see most recently Przewdzicki 2000, 2005; Ọla Orié 2001, 2003; Nevins 2010; Dresher 2013; Archangeli & Pulleyblank 2015; van der Hulst 2018). The contrastive hierarchy analysis in this chapter follows closely the analyses in Dresher (2013, 2015).

2.3.1 Phonological in/activity as insight to features

In the way of a concrete example, let us consider the Ifẹ variety of Yoruba which displays seven oral vowels in monosyllables: /i, e, ε, a, ɔ, o, u/ (Ọla Orié 2001, 2003).² In Yoruba vowel harmony, non-final vowels must correspond to root-final vowels in tongue root advancement/retraction, as shown in the first column in (35). This is an example of leftwards or anticipatory vowel harmony in contrast to the rightwards or perseveratory systems we saw previously in Bantu and Old Norwegian height harmony. As shown in the right column in (35), high vowels are non-alternating (neutral) segments in target positions.

(35) Ifẹ Yoruba ATR/RTR harmony in non-low vowels

	Harmonising (mid vowels)		Non-harmonising (close vowels)	
ATR HARMONY	ebè	‘heap of yams’	igbe	‘noise’
	ògèdè	‘incantations’	ìrèké	‘sugarcane’
RTR HARMONY	εsè	‘foot’	ìgbé	‘excrement’
	ògèdè	‘banana, plantain’	ìròlé	‘evening’

The correct acquisition of the the vowel patterns in (35) requires the language learner to assume two micro-cues (i.e. two phonological feature labels). To keep this illustration simple, I ignore for the moment labial and low vowel contrasts. One tongue root feature is necessary to discriminate harmonising vowels – e.g. retracted [ɛ] vs. advanced [e] – and a

²The distribution and harmonic behaviour of nasal vowels in Yoruba is less well understood (Ọla Orié 2003, pg. 7, fn. 10), and for simplicity’s sake I do not discuss them further at this time.

second feature is required to distinguish non-alternating, close [i] from harmonising, open [e, ɛ]. I will assume the feature labels [RTR] and [close] (cf. Archangeli & Pulleyblank 1989, van der Hulst 2012), but the choice of feature labels is not crucial to the analysis at hand. The important thing is that we need some way of differentiating groups of segments which are differentiated by contrasts and alternations.

The CCH holds that the phonemic inventory is defined by the set of active phonological features and feature co-occurrence restrictions required to express a language's phonological regularities (32). The two phonological features implied in (35) – [RTR] and [close] – minimally produce a three segment inventory and maximally four, depending on the permitted or prohibited co-occurrence of [RTR] and [close] features, as illustrated in (36). As the vowel specifications in (36) illustrate, I assume representations are maximally parsimonious – every unique feature specification, non-specification, and co-occurrence labels or defines a separate segment – and I relegate non-contrastive differences in segments to phonetic implementation. In section 2.3.2, I outline how the contrastive hierarchy approach assigns the feature specifications in (36).

(36) Possible [RTR] / [close] feature combinations

1) no restrictions	2) *[RTR, close]
features phonemes	features phonemes
[]	[]
[RTR]	[RTR]
[close]	[close]
[RTR, close]	

In Ifẹ Yoruba, there are no underlying [RTR, close] vowels */ɪ, ʊ/, and /i, u/ do not participate in [RTR]-harmony: e.g. [ìgbɛ́], *[ìgbé] in (35). In word-medial positions, close vowels are transparent to [RTR]-harmony patterns, as shown below in (37). In other words, /i, u/ are neutral (non-alternating) and like consonants are simply skipped by [RTR]-harmony – [èlùbɔ́], *[èlùbɛ́]. [RTR, close] vowels are an illicit output. These patterns indicate to the speaker the micro-cue that *[RTR, close] [ɪ, ʊ] vowels are not permitted. Ifẹ Yoruba therefore assumes the second inventory in (36), including only /ɛ, e, i/ vowel-types.

(37) Transparent word-medial close vowels in Ifẹ Yoruba

ATR HARMONY		RTR HARMONY	
ògùrò	‘stick for stirring’	orúkò	‘name’
éurò	‘bitter-leaf’	èlùbɔ́	‘yam flour’
oríwò	‘boil, tumor’	ɔ́dídɛ	‘parrot’
èbúté	‘harbour’	éurɛ́	‘goat’

Harmony languages like Ifẹ Yoruba are very common, where a lack of contrast in non-derived environments (i.e. /i/ – */ɪ/ in root-final or trigger positions in Yoruba)

are correlated with neutral harmony patterns like (35, 37). It is likely that the lack of underlying distinctions motivates the speaker to assume that her phonological grammar prohibits such contrasts (e.g. *[RTR, close] in Ifẹ Yoruba). Phonological contrastivity (or ‘harmony pairing’, Baković 2003) therefore often plays an explicit explanatory role in harmony analyses (e.g. Steriade 1987, Krämer 2003, Nevins 2010, etc.). Kiparsky & Pajusalu (2006, p. 1) claim categorically that vowel harmony processes are determined by phonological contrastivity, excluding asymmetric contrasts from harmonising categories out of principle:

The scope of a harmony process in a language is determined by its phonological inventory in two respects. First, harmony spreads a feature to the fullest extent that the inventory allows: morphological restrictions aside, *all* lexically contrastive vowels participate in vowel harmony unless some constraint on the distribution of the harmonic feature prevents it. Secondly, *only* lexically contrastive vowels participate in vowel harmony, or, to put it another way, lexical harmony is typically *structure-preserving*, in the sense that it introduces no new vowel types.

Though theories define contrastivity in different ways, Kiparsky and Pajusalu’s first generalisation appears to be typologically correct; there are no known cases where a segment can be shown in its phonological patterning to be contrastive for some harmony feature [F] but nevertheless categorically fail to undergo [F]-harmony. There are however important apparent exceptions to their second generalisation. For instance, another variety of Yoruba spoken in Ekiti, Nigeria, displays the same 7V oral vowel inventory as Ifẹ Yoruba in non-derived environments (Ọla Orié 2003), but as shown in (38), close vowels in Ekiti Yoruba undergo [RTR]-harmony, deriving non-underlying [RTR, close] [ɪ, ʊ] vowels. Phonetic studies of related dialects with derived [RTR, close] vowels such as Akurẹ Yoruba have shown that these cases of harmony allophony in close vowels involve categorical ATR/RTR alternations on par with mid vowel patterns. This is demonstrated by statistically significant mean F₁ differences in close vowels in ATR/RTR environments (Przedziecki 2000, 2005; Starwalt 2008). Phonologically, this means that Ekiti Yoruba allows [RTR, close] co-occurrence, as illustrated by the harmonising close vowels in (38). Following the CCH, Ekiti Yoruba speakers therefore assume the first vowel inventory in (36), which includes all possible [RTR] and [close] feature specifications and combinations, producing the symmetrical inventory /e, ɛ, i, ɪ/.

(38) **Harmonising word-medial close vowels in Ekiti Yoruba**

ATR HARMONY	èbúté	‘harbour’	
	eúrò	‘bitter-leaf’	
RTR HARMONY	èlùbú	‘yam flour’	*èlùbú
	òdíde	‘parrot’	*òdíde

Thus, Ekiti and Ifẹ Yoruba differ specifically in whether or not [RTR, close] co-occurrence is permitted or not. Only three non-low front vowels are minimally or distributionally contrastive in both varieties; that is, in non-derived environments, neither Ekiti nor Ifẹ Yoruba ever display [RTR, close] vowels. Nevertheless, inventory asymmetries like unpaired /i, u/ in Yoruba may either behave harmonically or neutrally with respect to [RTR] vowel harmony. Ifẹ Yoruba displays the ‘structure-preserving’ type in the sense of Kiparsky (1985) and Paradis & LaCharité (2011) – computing only

distributionally contrastive vowel qualities – whereas Ekiti Yoruba is ‘non-structure-preserving’, where [RTR, close] feature co-occurrence is permitted and harmony is allowed to derive non-underlying retracted close vowels. Similar cases of assimilatory allophony are not uncommon and are attested for example in Anywa (Nilotic) dental harmony (Mackenzie 2016) or regressive voicing assimilation in Russian (Halle 1959; D. Hall & Drescher 2016).

These kinds of distributional facts while useful for the characterisation of surface harmony patterns are often arguably given too much weight in the characterisation of sound inventories and permitted contrasts; see e.g. Kiparsky (2017) for a discussion of the ramifications of differing distributional definitions of underlying sound inventories. I do not attribute any synchronic significance to the fact that Ekiti Yoruba displays differing sets of surface contrasts in harmony derived and non-derived environments. In the framework I advocate here, inventories are built from the sum of representational micro-cues generalised according to the CCH from phonological patterning. It is of secondary importance if the generalised segments are ‘phonemes’ in the traditional sense or not. Since /ɪ, ʊ/ in Ekiti Yoruba have only historically developed as a result of RTR harmony which spreads from root-final syllables, it is historically predictable that /ɪ, ʊ/ do not occur in root-final (non-derived) positions. In other words, the lack of /ɪ, ʊ/ in underlying representations in Ekiti Yoruba may be construed as an accidental gap. They are ‘quasi-phonemes with defective distributions’ in the sense of Janda (1999) – occurring in complimentary distribution with /i, u/ but are nevertheless phonologically distinctive. Given the differing close vowel harmony patterns which evidence a *[RTR, close] co-occurrence micro-cue in Ifẹ Yoruba but not in Ekiti Yoruba, I suggest that whether /ɪ, ʊ/ occur in non-derived environments is possible but not necessary for Ekiti Yoruba speakers while prohibited for Ifẹ Yoruba speakers.

The key insight here is that feature and feature co-occurrence micro-cues are generalisable from phonological in/activity (e.g. non-/harmonisation). In the acquisition of their phonology, speakers must identify what active or contrastive features and feature combinations are relevant and necessary for their phonology via segmental contrasts and alternations: e.g. [RTR] and [close] in Ekiti Yoruba but [RTR], [close], and *[RTR, close] in Ifẹ Yoruba. These features and feature co-occurrence constraints define the language’s phonemic inventory: e.g. /e, ε, i, ɪ/ in Ekiti Yoruba but only /e, ε, i/ in Ifẹ Yoruba. As shown by this basic comparison of Ifẹ and Ekiti Yoruba dialects, asymmetric distributions – e.g. no [RTR, close] vowels in underlying representations in Yoruba – introduce the potential for variation, which helps explain the typological correlation between vowel harmony variation and asymmetric inventory shape.

2.3.2 The division of sound inventories into feature classes

As we have seen in the foregoing Ifẹ and Ekiti Yoruba comparisons, speakers can discern their language’s total set of active phonological features and permitted feature co-occurrences using phonological activity alone (i.e. via contrasts / alternations). And differences in features and feature combinations define differences in their sound inventory size / shape, which simultaneously set predictable limitations on vowel harmony outputs – resulting in the cross-linguistic correlation between sound inventory asymmetry and disharmony in harmony languages. But once a speaker has generalised her sound

inventory, what relationship or organisation is there between her active phonological features?

In early phonological work, the answer to this question would be none; speech sounds were conceived of as ‘bundles’ of features with no definable internal organisation (Bloomfield 1933, Chomsky & Halle 1968). But later work has identified recurring subsets of features which may pattern together in processes such as assimilation, dissimilation, neutralisation, and so on. This suggests that features may be organised into classes or families which may behave as a unit. For example, in many languages we find nasal place assimilation where a nasal may assimilate to labial, coronal, and velar consonants: e.g. /Np/ → [mp], /Nt/ → [nt], or /Nk/ → [ŋk]. This may be interpreted as the simultaneous spreading of all features which characterise place of articulation (McCarthy 1988). In harmony systems, consonants are typically transparent/invisible to vowel harmony, and vice versa – vowels are transparent to consonant harmony – demonstrating cohesive independent classes. Class behaviour of this kind suggests that there is some internal organisation of features, resulting in coherent patterning of all features which characterise place of articulation in nasal place assimilation or all vocalic features in vowel harmony. This insight is formalised in so-called feature geometry and its theoretical derivatives (Clements 1985, 2001; Hayes 1986; McCarthy 1988; Halle 1995; Padgett 1995, 2002; Morén 2003, 2006, 2007; Youssef 2010; Iosad 2012, 2017a), which model class-like behaviour as some grouping or hierarchical relationship between related phonological features; see Clements (2006) and Uffmann (2011) for general overviews.

The fundamental insights of feature geometry – the economic hierarchical organisation of features informed by phonological behaviour – is recapitulated in the Contrastive Hierarchy or Modified Contrastive Specification approach to phonological contrast (Dresher, Piggott & Rice 1994; Dresher 2003, 2009, 2013). As described in chapter 1, this method uses contrastive feature hierarchies to model segmental representations and segmental relations via hierarchically nesting featural contrasts within the scope of other features. As described by Iosad (2017a, p. 42):

The hierarchy is essentially a bootstrapping device, which allows the learner to introduce order into the system of phonological contrasts by breaking the phonological space down into more manageable subinventories.

While I assume these sub-inventories are specified by non-innate and language-particular features – posited by the learner on the basis of phonological in/activity as demonstrated in section 2.3.1 – speakers must nevertheless have some universal method for implementing the contrastive hierarchy device (Dresher 2014, 2018). This is modeled by the Successive Division Algorithm (SDA; Dresher 2005, 2009; D. C. Hall 2007; Mackenzie 2013, 2016).

I adapt the SDA to the current framework in the following way, drawing significant insights from Iosad (2017a). As defined in (39) – modified from D. C. Hall (2007, p. 31) – the SDA consists of three important components: 1) sound inventories are hierarchically divided into binary-branching feature classes (hierarchical organisation of features), 2) at each division, sub-inventories become associated with a feature-node (geometric grouping into sets), and 3) the relative hierarchical ranking of features is cross-linguistically variable (emergent phonological classes). Sub-inventories of each feature contrast (e.g. [RTR] /ε, ɔ/ vs. (non-RTR) /e, o/) are differentiated by feature non-/specification; the marked (dominant) set is assigned a feature-node **F** and a privative feature specification [F] (e.g.

RTR[RTR] /ε, ɔ/), while the unmarked (recessive) set bears an empty or bare node **F**[] and is non-specified for the feature (e.g. **RTR**[] /e, o/). A practical illustration of the SDA is provided in the following section 2.3.3.

(39) **Successive Division Algorithm with emergent features and feature-nodes** (adapted from D. C. Hall 2007, p. 31)

- a. The input (I) to the algorithm is one or more ordered feature and feature co-occurrence micro-cues.
- b. If I is found to contain a feature, then it is divided into two (non-empty) sub-inventories: a marked set M, to which is assigned **F**[F], and its unmarked complement set \bar{M} , to which is assigned **F**[], obeying [F, G]/*[F, H] co-occurrence restrictions.
- c. M and \bar{M} are then treated as the input to the algorithm; the process continues until all feature cues are divided

As indicated in this outline, I follow Iosad (2017a) in assuming that the SDA assigns both feature specifications and feature geometric nodes. In Iosad's approach, feature-nodes have principally two functions: 1) feature-nodes define contrastivity – bearing a feature-node **F** indicates contrastivity for the feature [F] – and 2) feature-nodes define locality domains in classic autosegmental phonology fashion (cf. Avery & Rice 1989, Odden 1994). In other words, a segment which bears the feature-node – represented as **F** – is guaranteed to be visible to a process which spreads [F] and vice versa; a segment lacking a node **F** cannot be involved in processes spreading [F]. Practical examples using the above Yoruba data are provided in section 2.3.3.

Feature-nodes thus provide the organising structure which define segment classes and which phonological processes such as vowel harmony target. However, in contrast to Iosad (2017a) who incorporates the Parallel Structures Model of feature geometry (cf. Morén 2003, 2006, Youssef 2010, Iosad 2012), I posit simply that feature-nodes emerge in the same way as features. That is, feature-nodes are feature specific (e.g. **CORONAL**[coronal] and **DORSAL**[dorsal]) rather than class specific (e.g. a common place-node **V-PL**[coronal] and **V-PL**[dorsal]). In other words, I assume no relationship between phonological features or feature-nodes beyond that defined by the language-particular contrastive feature hierarchy. As illustrated below in section 2.4, class-like behaviour – which motivates geometric theories – is adequately recapitulated in the contrastive hierarchy approach, and I demonstrate how we can capture class-like feature spreading and neutralising processes without requiring innate nodes or class relationships independent of those defined by the contrastive feature hierarchy.

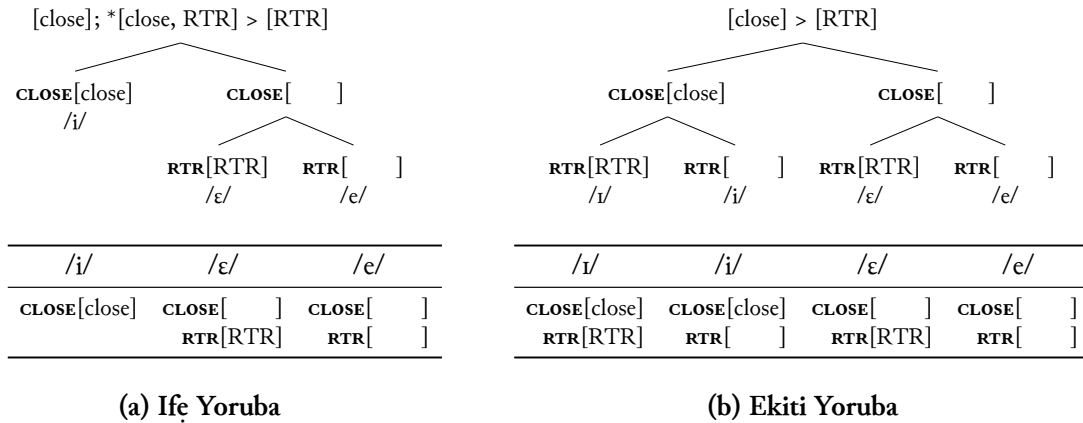
2.3.3 Applying the Successive Division Algorithm

As an illustration of the SDA in practice, consider again our simplified Yoruba vowel inventories: Ifẹ {i, ε, e} and Ekiti {i, ɪ, ε, e}. The set of features and co-occurrence restrictions which define these inventories was determined via the contrasts and alternations outlined in section 2.3.1: i.e. [RTR], [close], and *[close, RTR] in Ifẹ Yoruba and just [RTR] and [close] for Ekiti Yoruba. The SDA successively divides a set of features. For any given feature pair, there are two potential inputs (I) to the SDA: [RTR] > [close] or

[close] > [RTR]. These different orderings may result in differing feature specifications in asymmetric inventories. The grammatical effects of such representational differences is the focus of chapter 3, and for simplicity's sake I will consider only [close] > [RTR] orderings in Fig. 2.3 for ease of illustration. Full contrastive feature hierarchies for each language can be found in this thesis' appendix (see sections A.1/A.2).

In step one (39a), we supply each dialect's representational cues as the input (I) to the SDA: [close]; *[close, RTR] > [RTR] for Ife Yoruba and just [close] > [RTR] for Ekiti Yoruba. In step two (39b), the SDA divides the inventory into two groups based on the first posited feature. Any branches not permitted by prohibited *[F, H] or obligatory [F, G] co-occurrence micro-cues are eliminated – barring the left branch containing *[close, RTR] /i/ in the Ife Yoruba contrastive hierarchy in Fig. 2.3a.

Figure 2.3: Alternative contrastive feature hierarchies of Yoruba vowels



In Fig. 2.3, the SDA first defines a [close] contrast. This means that all segments are ‘within the scope of [close]’. In other words, all segments are specified **CLOSE**[close] or non-specified **CLOSE**[]. After dividing the inventory into marked [close] and unmarked non-close sub-inventories, the SDA input still contains a second feature [RTR], and the process repeats (39c). The SDA then creates divisions into marked [RTR] and unmarked non-RTR. In Ife, the co-occurrence of *[close, RTR] features is prohibited; the SDA thus only creates [RTR] divisions in the non-close domain. In Ekiti Yoruba by comparison, there is no restriction against [close, RTR] co-occurrence, resulting in symmetric [RTR] contrasts in close /i, i/ and non-close /ε, e/ vowels. With no more micro-cues requiring division, the process is complete – resulting in a three-way inventory of [close] /i/, [RTR] /ε/, and least marked [] /e/ in Ife Yoruba but a symmetric four-way inventory including [close, RTR] /i/, [close] /i/, [RTR] /ε/, and least marked [] /e/ in Ekiti Yoruba.

The application of the SDA has interesting consequences for feature specifications, particularly in asymmetric inventories. In Fig. 2.3a, the Ife Yoruba inventory, /i/ is the only close vowel and has no other feature specification. Its [close]-specification alone maximally distinguishes it from all other non-close segments. It is therefore underspecified or non-contrastive for the harmony feature [RTR] (having no **RTR** node). In other words, only non-close vowels /ε, e/ are contrastive for [RTR]; /i/ has no minimally paired [close, RTR] */i/ counterpart. This produces a minimal harmonic pair

between (harmonising) [RTR] /ɛ/ and (non-RTR) /e/ in contrast to non-harmonising [close] /i/ – which lacks any harmonic alternate */i/. The ranking [close] > [RTR] puts /i/ outside the scope of [RTR]; /ɛ, e/ therefore form a natural class – non-close vowels or vowels contrastive for [RTR]. This predicts that /i/ – lacking the **RTR** node – should be invisible to RTR harmony, as is the case for Ifẹ Yoruba in (37). The basic generalisation is that Ifẹ Yoruba speakers have categorised their vowels broadly into harmonising and non-harmonising vowels (i.e. **RTR** /ɛ, e/ vs. RTR-underspecified /i/) and more narrowly into retracted vs. advanced vowels (i.e. dominant/marked [RTR] /ɛ/ vs. recessive/unmarked [] /e/).

In contrast to Ifẹ Yoruba, Ekiti Yoruba permits parallel [close] and [RTR] contrasts, resulting in a fully symmetric inventory. As this simple example illustrates, the common correlation between asymmetric inventory shape (i.e. non-contrastivity) and disharmony in harmony languages receives a simple explanation via feature co-occurrence restrictions. A version of the SDA which takes representational micro-cues as its input provides a straightforward method for defining sound inventories on the basis of segmental phonological surface patterns.

2.3.4 Features, feature-nodes, and specifications

Features and feature-nodes encoded by the SDA are very similar phonological objects; both emerge in the course of phonological acquisition and define similar segment relations. The key insight is that feature-nodes define class units while features define marked/unmarked asymmetries within feature classes. For example, in Fig. 2.3a, contrastivity for the harmony feature [RTR] is defined by bearing the **RTR** feature-node – thus distinguishing (contrastive) harmonising segments /ɛ, e/ from non-contrastive underspecified (**RTR**-node-less) /i/. In other words, the **RTR** feature-node defines the class of harmony participants in contrast to neutral non-participants. Within this broad distinction between contrastive/non-contrastive members defined by feature-nodes, sub-inventories of the contrastive set are distinguished by feature specifications. The marked (dominant) sub-inventory /ɛ/ is specified [RTR] while the unmarked (recessive) non-RTR /e/ sub-inventory is non-specified for [RTR]. Features and feature-nodes thus both encode similar relations of difference and sameness, only at different levels.

From this it follows that the SDA as defined in (39) produces three kinds of feature under/specification: marked **F**[F] (*contrastive specification*), unmarked **F**[] (*contrastive non-specification*), and \emptyset (*non-contrastive underspecification* in the absence of both feature specifications and feature-nodes). In this way, the SDA recapitulates the ternary distinction afforded by underspecification with binary features (i.e. [+F], [−F], \emptyset) but at the same time naturally reproduces the marked/unmarked (dominant/recessive) feature-asymmetries captured by privative features (i.e. [F] vs. []); cf. Iosad (2017a) and Ghini (2001).

(40) Ternary distinction in contrastivity and underspecification

/ɛ/:	RTR [RTR]	[RTR]-harmony trigger
/e/:	RTR []	[RTR]-harmony target
/i/:		transparent/neutral to [RTR]-harmony

Ternary contrasts are widely acknowledged in other phonological domains and constitute a problem for strictly privative approaches – cf. for example commonly accepted ternary distinctions in laryngeal features (Wetzels & Mascaró 2001; Honeybone 2005; Iverson & Salmons 2011; Strycharczuk 2012; Iosad 2017a). I argue that this trichotomy in feature distinctions is thus empirically necessary, and that the interaction of harmony in/activity and in/visibility observed in vowel harmony languages with neutral segments constitutes an analogous example of surface ternarity. This is illustrated above by the feature specifications and predicted harmony behaviours in (40) from the contrastive hierarchy in Fig. 2.3a.

2.4 Contrastive hierarchies and emergent feature geometry

In the version of the SDA defined in (39), I assume non-innate (feature specific) feature-nodes. This claim may seem like a significant weakening of the theory since it in principle predicts far greater variation in potential segment classes than traditional approaches to feature geometry which assume some universal organisation of feature classes. I argue this reduction is typologically more adequate. Though innate feature geometries set substantive limits on feature classes, they prove empirically too restrictive in the face of contradicting class behaviours. Moreover, this section illustrates that the principal insights of feature geometry are adequately reproduced by the contrastive feature hierarchy, which I illustrate by two examples of apparent feature class spreading and contrast deletion. In this way, the revised contrastive hierarchy approach strikes the right balance between hierarchical feature organisation – producing feature class behaviour – and flexible feature scope – producing cross-linguistic variation in attested classes.

2.4.1 Arguments from class spreading

In feature-geometric theories, it is assumed that features depend on organising class-nodes, as informed by common phonological behaviour or articulatory similarity (see Clements 2006 and Uffmann 2011 for general surveys). However, the number and types of class-nodes has remained an unresolved issue as languages display contradictory evidence. Two features display class-like behaviour when they are involved in the same phonological process. Two articulatorily related features may display class-like behaviour in one language, such as overlapping backness and labial features in Turkish vowel harmony (Kabak 2011), which may be construed as common place feature spreading. But in other languages, the same groupings may be mixed up: e.g. common spreading of tongue root (manner) and labial (place) features to the exclusion of backness in Khalkha (Mongolian, Svantesson et al. 2008). In other words, features appear to display some organisation, but it is nuanced and varying.

This intricate relationship between features and feature classes is predicted by the contrastive hierarchy approach given cross-linguistically variable feature contrasts, as suggested by Uffmann (2011, p. 665): ‘If learners posit new features on the basis of contrast they observe within a set of segments, it is quite possible that the contrastive hierarchy will to some extent be reflected in an emergent geometry.’ In other words, if we take feature scope differences in contrastive feature hierarchies seriously, then different feature groupings and different feature class-like behaviours are predicted to be possible.

To illustrate how the contrastive hierarchy captures class-like feature behaviour, let us consider Ndendeule (N.101), previously discussed in sections 1.2.2. Ndendeule displays overlapping height and RTR harmony, lowering and retracting /i/ → [e, ε], respectively, as illustrated in (41). Height and tongue root harmony features therefore display class-like behaviour in Ndendeule as reflected in their common application to high vowel targets. As seen in the harmony patterns in (41), /a/ is fully transparent to both harmony systems, neither undergoing nor triggering [open] or [RTR]-harmony.

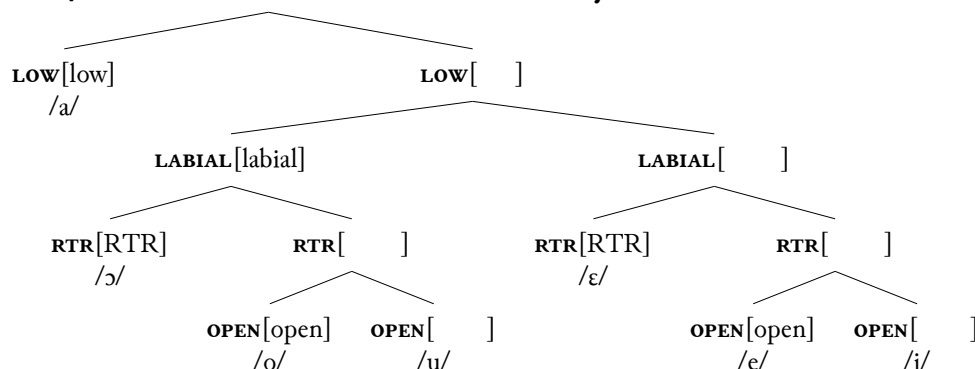
(41) Ndendeule (N.101) overlapping height and RTR harmony (Ngonyani 2004)

HIGH		y _i b-il-a	‘steal’-APPL.-FV.	t _u l-il-a	‘skin’-APPL.-FV.
MID	ATR	y _e mb-el-a	‘sing’-APPL.-FV.	b _o l-el-a	‘teach’-APPL.-FV.
	RTR	k _ε m-εl-a	‘call’-APPL.-FV.	t _ɔ l-εl-a	‘take’-APPL.-FV.
LOW		k _a ng-il-a	‘push’-APPL.-FV.		

Following the principles for building sound inventories from phonological activity and contrasts which were detailed in section 2.3.1, segmental alternations and contrasts in Ndendeule demonstrate the need for four phonological features: two harmony features as evidenced by height and tongue root harmony alternations, a labial feature as revealed by labial contrasts in root positions, and a fourth feature to distinguish neutral low /a/ from harmonising non-low vowels. Note that height and tongue root harmony in Ndendeule only applies to vowels that are contrastive for [labial]; in other words, [labial] co-occurs with other tongue root and (non-low) height features, producing symmetrical tongue root and height contrasts in labial /u, o, ɔ/ and non-labial vowels /i, e, ε/. The contrastive hierarchy approach provides a straightforward treatment of these Ndendeule classes, as shown in Fig. 2.4.

This contrastive hierarchy is evidenced by the following observations. The neutrality (transparency) of /a/ to height and tongue root harmony as well as the lack of low labial counterparts demonstrates that the [low] feature on /a/ does not co-occur with other features; that is, Ndendeule displays *[low, open], *[low, RTR], and *[low, labial] co-occurrence restrictions. In Ndendeule, the transparency or in/visibility of /a/ to either tongue root or lowering harmony indicates that [low] is outside the scope of harmony features. In neutral contexts – that is, following [low] vowels as in [kang-il-a] – harmony

Figure 2.4: Ndendeule contrastive feature hierarchy



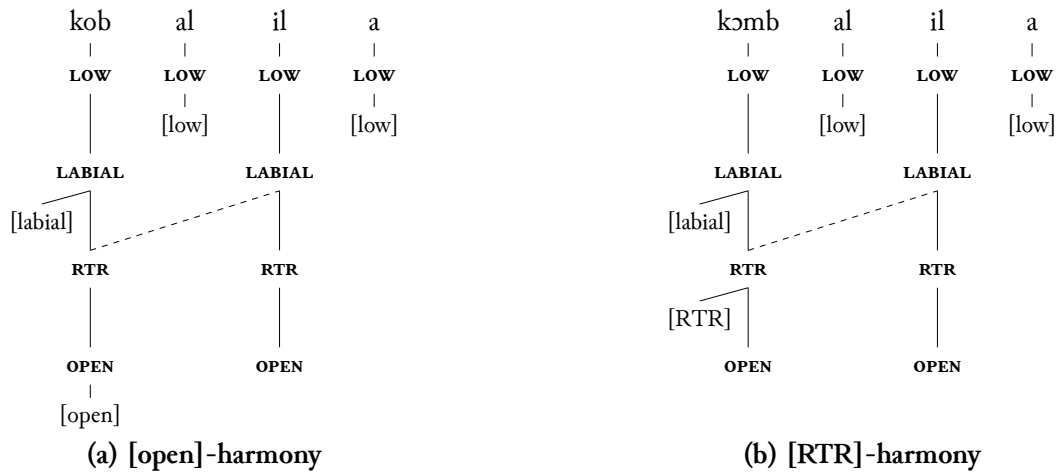
targets surface as high [i, u], revealing that the unmarked (default) value is non-open and non-RTR. In other words, the harmony feature values are [open] and [RTR] (and not [ATR] and [close]). High vowels /i, u/ are targets of both [RTR]- and [open]-harmony, which means they must be within the scope of both features, producing a ternary output: e.g. /i/ → [i, e, ε]. This ternary, asymmetric distinction reveals that the co-occurrence of the harmony features *[RTR, open] is not allowed in Ndendeule. If [RTR, open] were permitted to co-occur, then Ndendeule would display symmetric, four-way [RTR]/(non-RTR) and [open]/(non-open) /i, ɪ, e, ε/ contrasts (like we have seen in Ekiti Yoruba above). Secondly, Ndendeule harmony patterns indicate that /i/ must be within the scope of both features since it lowers and retracts to both [e] and [ε], respectively. From this it follows that though Ndendeule height and tongue root harmony are overlapping in the sense that they apply to the same targets, they are featurally non-overlapping in that no segment is simultaneously specified for both features: /ε/ is specified [RTR] and underspecified for [open] while /e/ is specified [open] and non-specified for [RTR] while /i/ is non-specified for both features.³

In summary, the evidence from Ndendeule phonological activity and visibility reveals four features, ordered as following: [low], [labial], [RTR], and [open]. [low] co-occurs with no other features, and [labial] co-occurs with all features but [low]. [RTR] and [open] do not co-occur. These feature and feature co-occurrence restrictions define a seven vowel inventory: unmarked (fully non-specified) /i/; [low] /a/; [labial] /u/; [open] /e/; [RTR] /ε/, [labial, open] /o/; and [labial, RTR] /ɔ/.

Returning to the problem of capturing feature class-like behaviour, a common assumption – following Clements & Hume (1995, p. 250) – is that phonological processes perform individual operations only. A phonological rule can thus target an individual feature or an individual node, and this insight is captured in a contrastive hierarchy approach which incorporates feature-nodes (cf. Iosad 2017a). Overlapping harmony systems like Ndendeule height and RTR harmony may be formalised as the single rightwards spreading of the **RTR**-node which spreads [RTR] and dependent features in (42) in [kɔbəl-ɛl-a] ‘stumble’-APPL.-FV. and [kɔmbəl-ɛl-a] ‘become thin’-APPL.-FV. (Deo Ngonyani, p.c.; cf. Ngonyani 2004). Note that the vertical ordering of feature-nodes in (42) follows from the hierarchical ranking of features in Fig. 2.4. In this framework, feature-nodes dock directly onto other feature-nodes; **RTR**-spreading thus targets the **LABIAL**-node on which **RTR** depends. Given that /a/ is non-contrastive with respect to [labial] (and therefore also non-contrastive for dependent [RTR]/[open] features), /a/ lacks a **LABIAL** node; it is therefore transparently skipped by **RTR**-spreading, as derivationally illustrated below.

³[RTR]-specified segments in Ndendeule are realised as [ε, ɔ] and not [ɪ, ʊ]. It is however worth noting that Bantu languages display significant variation in the surface realisation of RTR-segments, varying between [i, e, ε] and [ɪ, ɪ, e] surface contrasts (Maddieson 2003). I assume such non-contrastive differences between languages are strictly the responsibility of phonetic implementation and do not necessarily reflect underlying phonological feature values.

(42) Ndendeule height and tongue root harmony as RTR-node spreading in [kobal-ɛl-a] and [kɔmbal-ɛl-a]



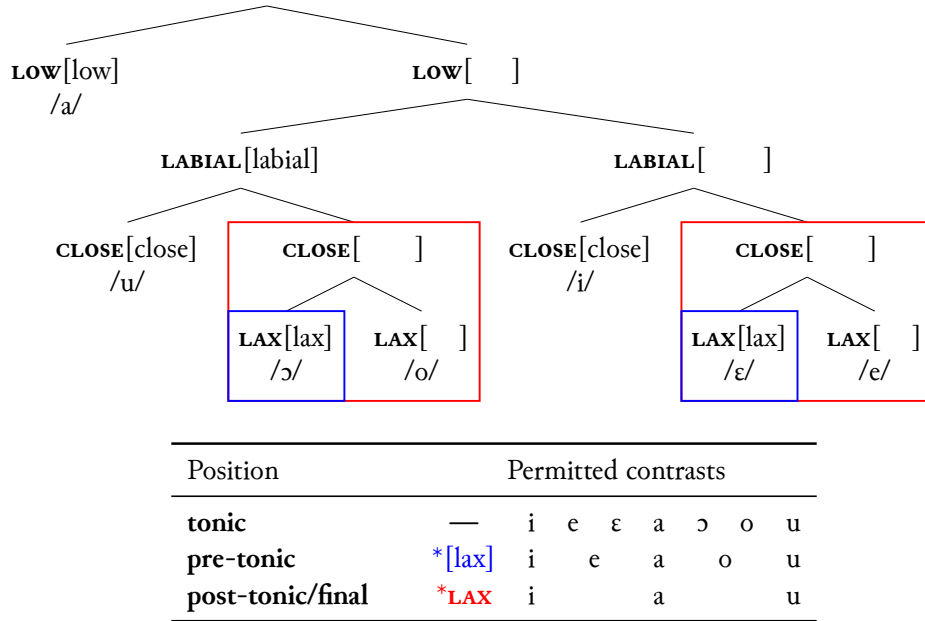
As this example illustrates, the hierarchical insight in Fig. 2.4 that height contrasts such as [open] /e/ vs. non-open /i/ are a sub-distinction of tongue root contrasts such as [RTR] /ɛ/ vs. non-RTR /i, e/ allows us to capture the class-like behaviour of [RTR] and [open] features using a single process of **RTR**-node spreading. The privative divisions in contrastive feature hierarchies predict the symmetric distribution of [open] and [RTR] featural contrasts within Ndendeule labial and non-labial vowels, and the exclusion of non-contrastive (neutral) segments. As illustrated in (42), the neutrality (transparency) of [low] /a/ is a straightforward effect of its non-contrastivity for [labial], [RTR], and [open] features, which makes /a/ invisible to **RTR**-spreading. In summary, the contrastive hierarchy approach can provide an elegant and non-stipulative treatment of class-like behaviour in dual harmony systems via common class-node spreading. In the following section, I demonstrate how analogous examples of group behaviour in non-assimilatory processes can be captured using the same techniques.

2.4.2 Arguments from contrast neutralisation

It bears repeating that features and feature-nodes are not dissimilar phonological entities, and phonological processes may target either of them. Let us consider positional neutralisation in Brazilian Portuguese. Like vowel harmony, neutralisation provides valuable insights into sub-segmental structure. In Brazilian Portuguese, we find a similar seven vowel inventory to Ndendeule on the surface, but the underlying featural make-up of the vowels is slightly different. In Brazilian Portuguese, tense/lax and close/open contrasts are positionally restricted (Wetzels 1992, 2010). As shown in Fig. 2.6, in stressed syllables all feature contrasts are permitted – /i, e, ɛ, a, ɔ, o, u/ – but in unstressed (pre-tonic) positions, tense/lax contrasts are reduced to [e, o] – barring *[ɛ, ɔ] vowels. In unstressed (post-tonic) final syllables, tense/lax and close/mid distinctions are neutralised simultaneously, leaving only labial and open contrasts: i.e. /i, a, u/. Note that the pattern of neutralisation – like the patterns of height and tongue root harmony in Ndendeule – is symmetrical in labial and non-labial vowels: /ɔ/ → /o/ → /u/ and /ɛ/ → /e/ →

/i/ to the exclusion of /a/ which is non-contrastive for labial and tense contrasts. The contrastive hierarchy approach provides the right architecture to account for both patterns using emergent class-nodes by the successive deletion of feature specifications and feature contrasts. Assuming the contrastive feature hierarchy in Fig. 2.6, with symmetrical tense/lax and close/open contrasts in labial and non-labial vowels, the neutralisation of tense/lax and close/open distinctions in unstressed syllables may be derived via positional constraints on lax feature specifications and feature-nodes.⁴ The low vowel /a/ is here labeled [low] to be consistent with the Ndendeule example above.

Figure 2.6: Positional neutralisation in Brazilian Portuguese



Following the contrastive feature hierarchy in Fig. 2.6, we may account for vowel reductions in unstressed (pre-tonic) positions using a *[lax] constraint – barring [lax]-specifications in unstressed (pre-tonic) syllables. A *[lax] constraint permits all segments non-specified for [lax]: i.e. /i, e, a, o, u/ to the exclusion of /ε, ɔ/ according to the representations in Fig. 2.6. But in post-tonic or final positions, neither tense/lax nor close/mid contrasts are permitted. In this respect, height and tense features behave as a unit, and this insight is captured in a contrastive hierarchy approach which incorporates feature-nodes. A constraint against *LAX bars any segments bearing the LAX-node. In other words, this constraint prohibits all segments which are contrastive for [lax], eliminating both LAX[lax] /ε, ɔ/ and LAX[] /e, o/ vowels. Contrastivity for [lax] is a sub-distinction only of contrastively non-close vowels in Brazilian Portuguese, as reflected in the contrastive hierarchy in Fig. 2.6 where [lax] contrasts are ordered after [close]. For this reason, the *LAX constraint thus naturally deletes both tense/lax and close/open

⁴As suggested by Spahr (2014), this approach to neutralisation as the deletion of feature specifications and contrast-defining feature-nodes can be thought of as a principled recapitulation of the Prague School archiphoneme. For conceptually similar approaches to Brazilian Portuguese neutralisation via contrast deletion and/or deletion of recursive layers of structure, see Spahr (2012, 2014) and Pöchtrager (2018).

contrasts on the surface. In word-final positions then, only higher scope [labial] and [low] contrasts between /i, a, u/ are permitted.⁵

As the class spreading and deleting examples in Ndendeule vowel harmony and Brazilian Portuguese positional neutralisation above illustrate, a contrastive hierarchy framework which incorporates emergent features and feature-nodes adequately recapitulates the fundamental insights of feature geometry while accommodating a limited amount of cross-linguistic variation in the following way: 1) Features emerge according to the Correlate Contrastivist Hypothesis – generalised as needed according to salient phonetic properties and phonological patterning (recurring ‘natural’ classes). 2) The SDA ensures that only as many phonemes are posited as are needed by the language (correlation of feature classes and inventory size/shape). 3) Feature class and sub-class relationships emerge in the contrastive hierarchy (hierarchical organisation of features). 4) Features depend on feature-nodes (economic spreading or delinking of whole groups of features captured as one operation). 5) Feature ordering and feature co-occurrence restrictions are optional (permitted cross-linguistic variation in feature classes). Together these components provide a principled, economic, and hierarchical approach to typologically varying feature classes.

2.5 Summary

Using harmony phenomena as a guiding insight to phonological representations, this chapter has explored the nature and subsegmental arrangement of phonological features and how these combine into larger structures to produce segments, phonological classes, and sound inventories. Building on the Contrastivist Hypothesis, I have demonstrated that the principle that a language’s phonemic inventory is defined by the set of features minimally necessary for the expression of its phonological regularities provides the necessary practical metric for speakers (and phonologists) to generalise inventories and inventory restrictions accurately from segmental phonological contrasts and alternations. Using representational micro-cues in the form of features and feature co-occurrence restrictions, I have shown how inventory-defining representational restrictions emerge from the acquisition of segmental phonology. Using a revised version of the Successive Division Algorithm which takes representational cues as its input, I have demonstrated how varying inventories and phonological activity/inertness asymmetries (e.g. harmony triggers vs. targets) are derived by asymmetries in privative phonological features and feature co-occurrence restrictions. These basic representational components achieve the right balance between broad theoretical and empirical coverage while remaining consistent with a fully emergent and substance-free approach to phonological features.

⁵The contrastive feature hierarchy in Fig. 2.6 is adapted from Spahr (2012, p. 26), but note that since vowel reduction in Brazilian Portuguese only targets [lax] feature contrasts, this analysis leaves open to question what the exact higher scope feature specifications are. The critical insight is that these reductions involve prohibitions against [lax] feature specifications and contrasts, but the analysis is compatible either with [close] /i, u/ vs. (non-close) /e, ε, o, ɔ/ or [open] /e, ε, o, ɔ/ vs. (non-open) /i, u/ feature specifications.

Chapter 3

The contrastive hierarchy approach to harmony

In the foregoing chapter, I have examined systematic exceptions in harmony processes as insights to phonological representations. In particular, following the Correlate Contrastivist Hypothesis outlined in section 2.3, we have seen how variation in phonological activity (e.g. the presence or absence of harmony alternations) evidences the presence or absence of differing representational micro-cues in the form of features and feature co-occurrence restrictions. I have demonstrated how the acquisition and definition of sound inventories can be achieved using a version of the Successive Division Algorithm which takes generalised representational micro-cues as its input. In the analysis of vowel harmony more particularly, this framework posits that the main locus of explanation for cross-linguistic variation lies in a limited range of representational variables (e.g. asymmetries in marked/unmarked feature values and prohibited/obligatory feature co-occurrence). However, thus far we have remained fairly agnostic about the mechanics of vowel harmony as a grammatical process and the important role feature scope asymmetries in contrastive hierarchies play in deriving variation in harmony locality.

In this chapter, I provide a broader exploration of the range of representational variation predicted by the SDA with particular focus on the role of feature nesting in contrastive feature hierarchies in explaining common asymmetries in feature under/specification, harmony locality, and conditional vs. non-conditional harmony systems. In particular, I outline the important role of feature ordering and positional restrictions on harmonising domains in deriving variation in harmony locality in section 3.1. These components provide the nuts and bolts of any harmony system. This approach is principally compatible with a wide range of grammatical frameworks. In section 3.2 I provide some simple formalisations which outline a more explicit model of how harmony processes may interact with and be directly limited by language-particular representational constraints. This framework provides a principled and concise account of all typologically common harmony behaviours: e.g. triggers, targets, transparent segments, blockers, etc. These are fairly basic examples of non-conditional harmony and neutral harmony behaviours, and in section 3.2 I illustrate how these categorical harmony patterns follow from inventory-defining representational cues in cooperation with the Successive Division Algorithm.

This method accurately captures the nuanced relationship between inventory shape, contrastivity, and harmony variation. However, not all harmony variation can be chalked

up to representational limitations introduced by inventory asymmetries. So far we have only considered categorical neutral harmony patterns – cases where segments *never* trigger or *never* undergo harmony regardless of morphophonological position, trigger–target similarity, and so on. In section 3.3, I widen the scope to consider more interesting cases where segments *sometimes* undergo harmony and *sometimes* not depending on trigger/target agreement for some orthogonal feature. The conditional nature of these harmony languages provides further important insights in the relation between phonological features in general and the role of dominant/dependent feature scope asymmetries in phonology more particularly. The combination of representational and grammatical limitations on harmonisation outlined in this chapter provide the foundation for a coherent and unified treatment of both conditional and non-conditional harmony and neutral harmony phenomena.

3.1 Harmony activity and locality according to the SDA

In this section, I take a more specific look at how representational cues pair with the SDA and positional restrictions on harmony domains to derive more narrow variation in harmony activity and locality. For the sake of illustration, I continue to explore cross-dialectal variation in Yoruba vowels and tongue root harmony.

3.1.1 Feature-nodes define harmony locality

Cross-dialectal and language-internal variation in Yoruba tongue root harmony illustrate how narrow micro-variation in harmony locality can be derived strictly representationally by varying the order and co-occurrence of representational micro-cues in the input to the SDA as defined in (39). Let us first consider differences in the visibility and/or activity of harmony target positions, which may either display harmonisation, blocking, or transparency. Standard Yoruba has the familiar 7V underlying oral vowel inventory as found in Ifẹ Yoruba and displays the same active vs. inactive harmony classes. The data from Standard Yoruba in (35), repeated below in (43), are equally valid for Standard Yoruba speakers (Ola Orié 2001, 2003). Like Ifẹ Yoruba, Standard Yoruba speakers do not display [(RTR), close] vowel alternations: i.e. [igbɛ́], *[igbɛ́́].

(43) Standard Yoruba ATR/RTR harmony in non-low vowels

	Harmonising (mid vowels)		Non-harmonising (close vowels)	
ATR HARMONY	ebɛ́	‘heap of yams’	igbɛ́	‘noise’
	ògèdè	‘incantations’	ìrèké	‘sugarcane’
RTR HARMONY	ɛsɛ́	‘foot’	ìgbɛ́	‘excrement’
	ògèdè	‘banana, plantain’	ìròlè	‘evening’

Put another way, Standard and Ifẹ Yoruba have identical sets of active phonological features and feature co-occurrence restrictions (i.e. [RTR], [close], and *[RTR, close] in this simplified example) as evidenced by identical alternating and non-alternating

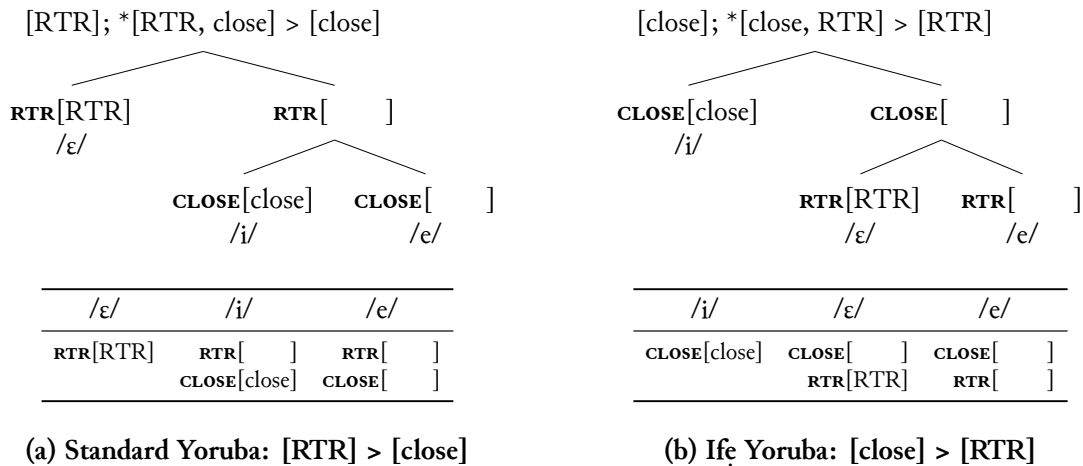
segments: harmonising /e, ε, o, ɔ/ vs. neutral /i, u/. However, the two varieties display a crucial difference in the behaviour of close vowels in word-medial positions. As illustrated below in (44), while neutral /i, u/ are transparent/invisible to RTR harmony in Ifẹ Yoruba, the same neutral vowels result in harmony blocking in Standard Yoruba.

(44) (Non-)transparent word-medial close vowels in Standard and Ifẹ Yoruba

Stand. Yoruba	Ifẹ Yoruba
orúk <u>ɔ</u>	ɔrúk <u>ɔ</u> ‘name’
èlùb <u>ɔ</u>	èlùb <u>ɔ</u> ‘yam flour’
odíd <u>ɛ</u>	ɔdíd <u>ɛ</u> ‘parrot’
ewúr <u>é</u>	éúr <u>é</u> ‘goat’

In other words, harmony can apply at long distances in Ifẹ Yoruba but is strictly local in Standard Yoruba. This difference in harmony locality reflects an important difference in feature scope predicted by the SDA. It is assumed in Contrastive Hierarchy Theory that the relative ordering and therewith the relative scope of features provided to the SDA is cross-linguistically variable. The SDA therefore predicts that for any two phonological features, there are two possible categorisations depending on the feature order: e.g. [RTR] > [close] or [close] > [RTR]. Both feature rankings are illustrated in Fig. 3.1.

Figure 3.1: Alternative contrastive feature hierarchies of Yoruba vowels

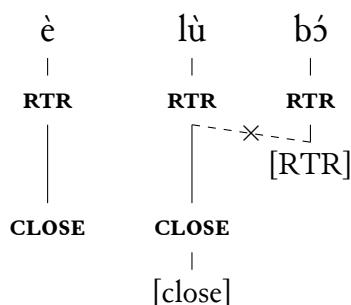


The alternative categorisation of [close] vowels in Ifẹ and Standard Yoruba illustrates an important variable in phonological representations afforded by the SDA: optional underspecification as an effect of differing feature scope in contrastive feature hierarchies. Specifically, as illustrated by Fig. 3.1, Standard and Ifẹ Yoruba varieties differ in the relative scope/size of their individual feature classes. As we have seen before, Ifẹ Yoruba speakers assume a [close] > [RTR] order – thereby dividing their sound inventory into broadly harmonising vs. non-harmonising vowels /i/ vs. /ε, e/ vowels and more narrowly into RTR/ATR classes /ε/ vs. /e/. By contrast, Standard Yoruba speakers assume the opposite order – [RTR] > [close] – dividing their vowel inventory broadly into RTR/ATR

classes /ɛ/ vs. /e, i/ and more narrowly into harmonising vs. non-harmonising /e/ vs. /i/ vowels. These alternative feature orderings have ramifications for feature specifications; compare *contrastively non-specified* **RTR**[] /i/ in Standard Yoruba in Fig. 3.1a but *RTR underspecified* /i/ in Ifẹ Yoruba in Fig. 3.1b. In other words, the optionality in relative ordering of [RTR] and [close] features results in variation in how many segments are *contrastive* for [RTR] – /ɛ, e, i/ in Fig. 3.1a but only /ɛ, e/ in Fig. 3.1b.

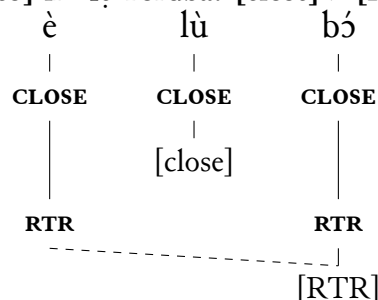
Since feature-nodes define locality domains (cf. Avery & Rice 1989, Odden 1994), this optionality in feature under/specification is reflected on the surface in apparent optionality in in/visibility (non-/transparency) to feature spreading processes like vowel harmony. To illustrate this difference derivationally, consider the form ‘yam flour’ [èlùbɔ́] in Standard Yoruba and [èlùbɔ́] in Ifẹ Yoruba. In Standard Yoruba, close vowels are contrastively non-specified **RTR**[] and therefore should be visible harmony targets. However, Standard Yoruba does not permit *[RTR, close] /ɪ, u/ vowels as we have seen in (37, 44). Thus, even though close vowels are predicted to be visible harmony targets in Standard Yoruba, spreading [RTR] to close vowels would result in an illicit output – an *[RTR, close] vowel. This results in the neutral blocking patterns observed in Standard Yoruba, as illustrated below in (45). Here only the relevant structures are represented; note that the hierarchical feature ranking [RTR] > [close] in Fig. 3.1a follows from the vertical ordering of feature-nodes in (45). [RTR]-specified vowels are non-contrastively underspecified for [close], as reflected by the lack of a **CLOSE** feature-node in (45) below and Fig. 3.1a above.

(45) [RTR]-harmony blocking in [èlùbɔ́] in Standard Yoruba (*[RTR, close])



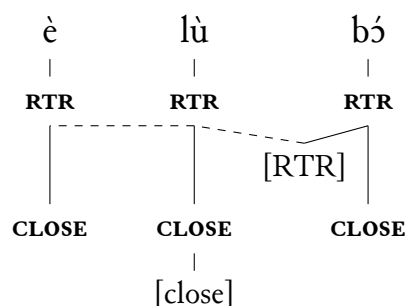
In comparison, dividing the same sound inventory by [close] first instead of [RTR] results in close vowels /i, u/ which are non-contrastively underspecified for the harmony feature, as in Ifẹ Yoruba (see Fig. 3.1b). This means that /i, u/ vowels, being non-contrastive for [RTR], have no **RTR** feature-node; cf. (45, 46). This predicts that close vowels in Ifẹ Yoruba – like consonants – will not be visible to [RTR]-harmony, as was observed in (44) above. Non-contrastive underspecification for the harmony feature derives transparent skipping of neutral /i, u/ vowels, as illustrated using feature spreading in (46) below.

(46) Transparency in [èlùbó] in Ifè Yoruba: [close] > [RTR] (*[close, RTR])



For the sake of completeness, consider the corresponding fully harmonic form [èlùbó] in Ekiti Yoruba, discussed above in (38). Ekiti Yoruba displays no [RTR]/[close] feature co-occurrence restriction. [RTR] contrasts are therefore equally distributed across [close] and non-close vowels, as indicated by the common **CLOSE** feature-nodes in (47). With no restriction on [RTR, close] correspondence, [RTR]-harmony applies equally to both [close] and non-close vowels in Ekiti Yoruba.

(47) Full [RTR]-harmony in [èlùbó] in Ekiti Yoruba



These examples illustrate how contrastive feature hierarchies constructed according to the SDA defined in (39) produce the right balance of feature class behaviours (hierarchical organisation of features) and cross-linguistic variability (optional feature co-occurrence / ordering). The key insight is that differences in phonological in/visibility (non-/transparency) are a reflex of differences in relative feature scope. In Standard and Ifè Yoruba, which feature is categorised as having broader and narrower scope has ramifications for feature specifications on /i/ and /ɛ/, either of which will be underspecified for one of the two features and redundantly specified for the other. This method thus captures the intuition that features are contrastive and redundant only in relation to other features. Contrastive hierarchies provide thereby an elegant mechanism by which language learners may arrive at equally viable but differing solutions to the basic problem of categorising asymmetric sound inventories into marked/unmarked feature classes. These examples demonstrate the power of representations in phonological explanation. The theory utilises the logical optionality in how to categorise asymmetric inventories into binary branching feature classes to explain correlated optionality in phonological behaviour of asymmetric contrasts. In this way, the contrastive hierarchy method accurately captures the common link between inventory asymmetries and harmony variation.

3.1.2 Language-internal variation in representations

This framework predicts a certain amount of flexibility, but hierarchically defining what segments count as contrastive and specified (and therewith visible and active) for a given feature does set substantive limits on phonological variation. A language learner of Standard or Ifẹ Yoruba where *[RTR, close] co-occurrence is not permitted is predicted to have two options: to categorise RTR-unpaired close vowels either as a subset of advanced (contrastively [RTR]-non-specified) vowels – the Standard Yoruba case – or as outside the scope of [RTR] altogether and therefore inconsequential with respect to RTR harmony – the Ifẹ Yoruba case. For any given asymmetric contrast, these are the two predicted options. And this choice of broader or narrower scope categorisation needs to be made individually for any given asymmetric contrast. The contrastive hierarchy approach therefore predicts that different unpaired classes of segments in one and the same language may display differing behaviours, and this prediction is borne out in Yoruba.

So far we have considered only non-low vowels in Yoruba dialects, and we have observed substantial variation in the harmony behaviour of close vowels. The behaviour of low vowels in Yoruba is by contrast remarkably uniform. The low, or what I will label [open], vowel /a/ in Yoruba is unpaired for and non-alternating with respect to the harmony feature (48a–d); no Yoruba dialect ever permits advanced low vowels (e.g. *[ə] or *[ɐ]). This asymmetry means that [open] either co-occurs with [RTR] or it does not – but not both. In other words, a Yoruba speaker either assumes that [RTR]/[open] co-occurrence is prohibited (*[RTR, open]) or obligatory ([RTR, open]).¹ The data in (48e–h) suggest that [open] /a/ is active with respect to [RTR]-harmony – across all Yoruba dialects – since root-final [a] is predictably preceded by [RTR] vowels (Ọla Oriẹ 2003). Thus, /a/ is specified [RTR, open].

(48) Harmonic blocking by /a/ in Yoruba tongue root harmony

a.	abɔ̌	‘female’	e.	ɔba	‘king’
b.	abɛ̌	‘crown’	f.	ɛpà	‘peanut’
c.	àgbèdɛ̌	‘blacksmith’	g.	òyàyà	‘cheerfulness’
d.	ahorɔ̌	‘ruins’	h.	érɛ́ta	‘place of ogun worship in Ifẹ’

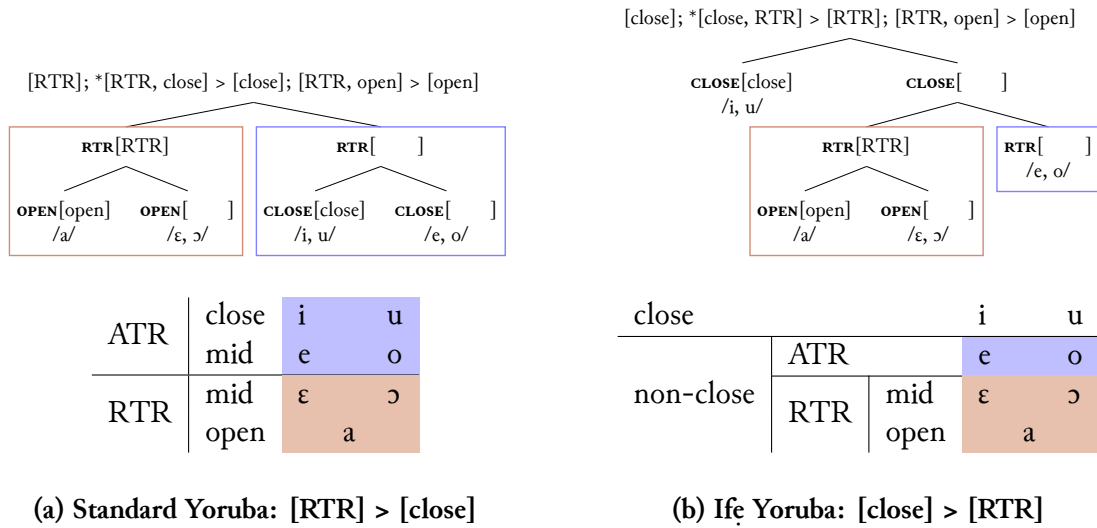
Adding the [open] vowel /a/ to our set of [RTR]-specified vowels in the contrastive feature hierarchies in Fig. 3.1, as illustrated in Fig. 3.2, we can conclude that all vowels are contrastive for [RTR] and therewith visible to [RTR]-harmony in Standard Yoruba (i.e. [RTR] has broadest scope), but Ifẹ Yoruba displays a mixed case: non-alternating close /i, u/ are non-contrastively underspecified for [RTR] and therefore display transparency

¹Obligatory feature co-occurrence micro-cues can be interpreted as a form of licensing (cf. Iosad 2017a, §4.2.5; Walker 2005, 2011), as in (i), or attracting force in Magnetic Grammar (D’Alessandro & van Oostendorp 2018): i.e. [RTR] ⊂ [open]. According to these approaches, the relationship between [RTR] and [open] features is uni-directional. [open] must co-occur with [RTR] but not necessarily the other way around. For example, the Yoruba inventories Fig. 3.2 include [RTR, open] /a/, [RTR] /ɛ/, but no *[open] /ə/.

(i) LICENSE([open], [RTR]): ‘[open] must be associated with [RTR]’.

(e.g. $\text{èlùb}^{\text{ó}}$), but non-alternating /a/ must be specified **RTR**[RTR] and is therefore a consistent harmonic trigger (e.g. [éréta]). Asymmetries in the behaviour of different harmonically unpaired groups, like close and low vowels in Ifẹ Yoruba, receive a unified analysis within the contrastive hierarchy approach. The key insight is that there is a one-to-one correspondence between phonological in/visibility and non-/contrastivity as defined by feature scope in contrastive feature hierarchies. Each asymmetric contrast may be categorised within or outside the scope of any relevant feature, independently of how other asymmetric contrasts are ordered. As illustrated in the full vowel contrastive hierarchies in Fig. 3.2, [RTR] has narrower scope than [close] in Ifẹ Yoruba but broader scope than [open]. In Ifẹ Yoruba, close /i, u/ vowels are therefore invisible to the harmony process while **OPEN**[open] /a/ is conversely predicted to be a licit trigger of [RTR]-harmony, being within the domain of [RTR]. In both dialects, the harmony pairs /ε, ɔ/ and /e, o/ are still minimally matched in their feature specifications, differing only with respect to their [(RTR)]-specifications.²

Figure 3.2: Standard and Ifẹ Yoruba contrastive feature hierarchies

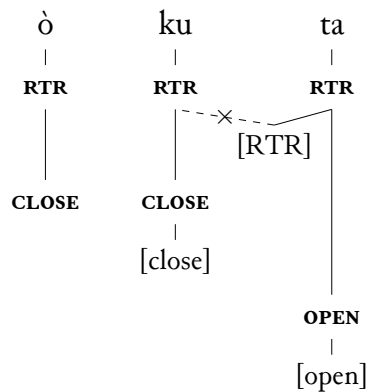


Following a contrastive hierarchy approach which incorporates emergent feature-nodes, the variation in these Yoruba harmony patterns – even within one and the same language – can be strictly representationally derived. The model does not require any difference in the two dialects' harmony grammars. In principle, any feature spreading, copying, or correspondence mechanism between [RTR]-contrastive vowels – as defined by the contrastive feature hierarchies in Fig. 3.2 – will produce the corresponding transparency and blocking patterns in (49), using Ifẹ Yoruba [òkuta] versus Standard Yoruba [òkuta] 'stone' as an example. As illustrated in this example, [open] /a/ is an

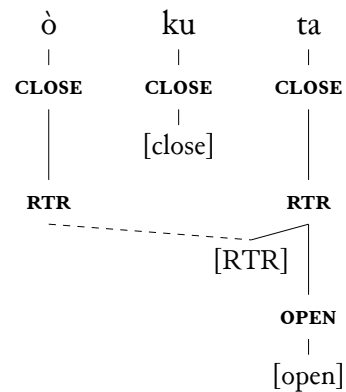
²Note that feature-nodes define contrastivity for a feature, and therefore /ε, ɔ/ and /e, o/ vowels have slightly differing feature-nodes because they are contrastive for different features – [open] and [close], respectively. These orthogonal features occur on separate sub-inventories in Yoruba dialects. For example, in Standard Yoruba, [RTR] vowels are contrastive for [open] – /ε, ɔ/ vs. /a/ – and /ε, ɔ/ have therefore a **OPEN** feature-node which /e, o/ do not have (since they are not contrastive for [open]). In the same way, non-RTR vowels are contrastive for [close] – e.g. /e, o/ vs. /i, u/ – and therefore /e, o/ have a **CLOSE** feature-node which /ε, ɔ/ do not have (since they are not contrastive for [close], */i, u/). Harmony pairs thus may differ with respect to feature-nodes but will be minimally paired with respect to harmony features.

[RTR]-specified feature-donor in both dialects, and close vowels fail to undergo [RTR]-harmony in both dialects, indicating a constraint against *[RTR, close] vowels. Given the [close] > [RTR] feature ordering in Ife Yoruba, close vowels are non-contrastive / underspecified for [RTR]. Spreading [RTR] to the closest contrastive vowel results in transparent skipping of the word-medial close vowel in Ife Yoruba. But in Standard Yoruba, the alternative feature ordering [RTR] > [close] leaves close vowels contrastively non-specified for the harmony feature – just like contrastively non-specified /e, o/. Close vowels are therefore visible but illicit (*[RTR, close]) targets of [RTR]-harmony in Standard Yoruba, resulting in neutral blocking.

(49) **Blocking and transparency in /òkuta/ in Standard and Ife Yoruba**



(a) Standard Yoruba [òkuta]:
[RTR] > [close]



(b) Ife Yoruba [òkuta]:
[close] > [RTR]

This detailed exploration of microvariation in Yoruba vowel harmony demonstrates how contrastive feature hierarchies constructed according to a version of the SDA which incorporates privative, emergent features and feature-nodes provides a straightforward and limited method for accommodating common neutral harmony patterns while enhancing both representational and grammatical economy. At the same time, the framework is flexible enough to capture the nuanced relationship between asymmetric inventory shape and harmony neutrality in a principled way – even narrow variation within one and the same dialect as we have seen in Ife Yoruba.

3.1.3 Language-internal variation in harmonising domains

The contrastive hierarchy method provides a lot of mileage in explaining cross-linguistic variation in harmony systems relying only on limited variation in the set, relative scope, and co-occurrence of phonological features. Representational differences do not, however, account for all cross-linguistic variation in harmony locality. Importantly, the harmonising domain – that is, what positions trigger and undergo harmony – must be defined for each harmony process, and positional restrictions on harmony domains are principally independent of representational factors, such as differences in the distribution of harmony contrasts. This is demonstrated by language-internal variation in the harmonising domains of dual harmony systems.

For instance, Gungu (J.10) displays overlapping ATR and lowering vowel harmony (Kutsch Lojenga 1999, Diprose 2007), which results in four-way alternations in non-low vowels (e.g. [i, ɪ, e, ɛ]). Unlike other dual harmony systems we have considered previously, Gungu ATR and lowering harmony display differing harmonising domains. As was discussed in section 2.2.1, ATR harmony in Gungu is not positionally restricted. All [ATR]-non-specified vowels will assimilate to [ATR]-specified vowels wherever they occur. This is a so-called dominant/recessive harmony system, which can result in bidirectional spreading. In comparison, lowering harmony in Gungu is of the canonical Bantu type, spreading only from root-initial to non-initial syllables. Low vowels are transparent to both harmony processes. Example patterns are provided in (50) using reversion in/transitive /-ʊk, -ʊl/ suffixes. The harmony trigger vowel in each case is underlined.

(50) **Overlapping ATR and lowering harmony on Gungu verbal extensions**

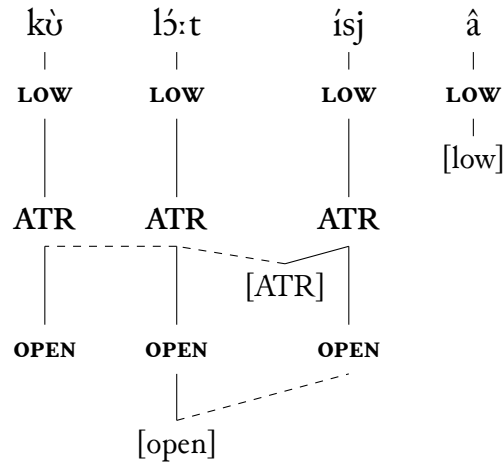
- a. kù-í:-úk-â ‘climb down’
- b. kù-βúk-úl-â ‘uncover’
- c. kù-b^wó:m-ók-â ‘be poured’
- d. k^w-ò:k-ól-â ‘extract’

As may be observed in the data above in (50), [ATR] and [open]-harmonies in Gungu display differing patterns. For example, [ATR] spreads from roots to prefixes – e.g. [ATR] [kù-í:-úk-â] vs. non-ATR [kù-βúk-úl-â] – but [open]-harmony only spreads (rightwards) from root-initial to non-initial syllables – e.g. non-open [kù-í:-úk-â] vs. [open] [kù-b^wó:m-ók-â], not *[kò-b^wó:m-ók-â]. Overlapping [ATR] and [open]-harmonies in Gungu sometimes even display differing harmony triggers and targets in one and the same form, providing clear evidence that the two harmony patterns are distinct processes with distinct harmonising domains. Diprose (2007, p. 54) provides two examples, reproduced in (51cd) below.

(51) **Directionally asymmetric ATR and lowering harmony in Gungu**

- a. /kù-sú:l-ísj-â/ → [kù-sú:l-ísj-â] ‘refuse’-CAUS-FV cf. [kù-sú:l-â] ‘to refuse’
- b. /kù-lí:ⁿd-ísj-â/ → [kù-lí:ⁿd-ísj-â] ‘wait’-CAUS-FV cf. [kù-lí:ⁿd-â] ‘to wait’
- c. /kù-ló:t-ísj-â/ → [kù-ló:t-ésj-â] ‘dream’-CAUS-FV cf. [kù-ló:t-â] ‘to dream’
- d. /kù-é-ísj-â/ → [kù-é-ésj-â] ‘bite’-CAUS-FV cf. [kù-é-â] ‘to bite’

The derivation of directionally asymmetric overlapping [ATR] and [open]-harmonies in Gungu is demonstrated below in (52) in the form [kù-ló:t-ésj-â] which displays an [open]-specified root /-lɔ:t-/ but an [ATR]-specified causative suffix /-ísj-/, which harmonise to one another. The causative suffix triggers anticipatory (right-to-left) harmony on the root and verbal prefix (cf. non-ATR [kùlɔ:tâ] ‘to dream’) while the root triggers perseveratory (left-to-right) lowering harmony on the causative suffix; cf. non-open harmony cases in (51ab). In (52), only relevant structures are represented. See A.5 in the appendix for full representations and a broader summary of Gungu harmony patterns.

(52) **Distinct domains of ATR and lowering harmony in Gungu**

Gungu overlapping ATR and lowering harmony above illustrates that independent harmony processes in one and the same languages may display differing positional restrictions on their harmonising domains. All non-ATR vowels are potential harmony targets in Gungu dominant / recessive ATR harmony while its height harmony system is sensitive to the language's metrical structure, spreading only from root-initial to non-initial syllables. Such independent harmony systems in one and the same language are not uncommon. A parallel example where a dual harmony system displays differing prosodic and metrical limitations is found, for instance, in Eastern Meadow Mari (Uralic) where vowels assimilate to root-initial syllables for backness but to stressed syllables for rounding (Vaysman 2009, Walker 2014). These differences within dual harmony systems demonstrate that positional restrictions on harmony domains are optional and may be defined differently for each harmony process.

3.2 Formalising representational and grammatical limitations on harmony

We now have a good handle on the basic structure and specifications required to account for typologically common representational and grammatical variation in vowel inventories and vowel harmony systems. With this background in place, we can begin to define a more formal account of how harmony mechanisms interact with and are limited by representations defined by the SDA and positional restrictions on harmonising domains.

3.2.1 Translating contrastive hierarchies to ranked constraints

We have seen how the acquisition of sound inventories and active phonological features may proceed from the generalisation of representational micro-cues in the form of feature labels $[F]$ / $[G]$ and obligatory/prohibited feature co-occurrence restrictions $[F, G]$ / $*[F, G]$. Ultimately the grammatical formalisation of these micro-cues could take different forms, and I do not commit to any one system at this time. In this section, I

provide a brief illustration of one way this approach may be grammatically implemented. Regardless of the model, the important insight is that phonological operations are limited by representational generalisations. Mackenzie & Drescher (2004) and Mackenzie (2013, 2016) have devised an algorithm which captures this idea using faithfulness and feature co-occurrence constraints to convert contrastive feature hierarchies to non-derivational constraint rankings. I provide a simplified privative interpretation of this approach in (53). In this section, I outline only the broad points of this method; for finer details, see Mackenzie (2013, 2016).

- (53) **Converting a contrastive hierarchy to a constraint ranking** (adapted from Mackenzie 2013, p. 305)
- a. Select a faithfulness constraint $\text{MAX}[\text{F}]_i$, where $[\text{F}]_i$ is the highest ordered contrastive feature for which $\text{MAX}[\text{F}]_i$ has not yet been ranked. Rank $\text{MAX}[\text{F}]_i$ below any $\text{MAX}[\text{F}]$ constraints ranked by prior application of step (a) and above all other $\text{MAX}[\text{F}]$ constraints.
 - b. Above this faithfulness constraint, rank any co-occurrence constraints of the form $*[\Phi, \text{F}_i]$ or $[\Phi, \text{F}_i]$ where Φ consists of features ordered higher than $[\text{F}]_i$ and where contrastive specification of Φ is prohibited or obligatory in segments specified for $[\text{F}]_i$. If there are more contrastive features, go to (a); otherwise, end.

In the way of an example, we can convert the simple Ife Yoruba three vowel inventory in Fig. 3.1b which includes features [close], [RTR], and the co-occurrence restriction $*[\text{close}, \text{RTR}]$ in the following way. According to the first step of the algorithm in (53), the ranking of faithfulness constraints mirrors the ordering of features in contrastive feature hierarchies. In Fig. 3.1b, the highest ordered feature is [close]; therefore the highest ranked faithfulness constraint will be $\text{MAX}[\text{close}]$. Step (b) in the algorithm refers to feature co-occurrence restrictions which define inventory asymmetries in the distribution of [close] and higher ordered features. Since [close] has broadest scope/highest rank in Ife Yoruba, this step does not apply. After this, we have a second ordered feature [RTR], and the process therefore repeats. Step (a) dictates that $\text{MAX}[\text{RTR}]$ should be ranked after the previously ordered $\text{MAX}[\text{close}]$ constraint. Step (b) requires any [RTR] and higher (i.e. [close]) feature co-occurrence restrictions to be ranked above $\text{MAX}[\text{RTR}]$. In Ife Yoruba, $*[\text{close}, \text{RTR}]$ co-occurrence is not permitted – excluding the feature [RTR] within segments specified for [close]. A co-occurrence constraint $*[\text{close}, \text{RTR}]$ is therefore ordered above $\text{MAX}[\text{RTR}]$. At this point, there are no other features to be ordered, and the algorithm terminates.

The final constraint ranking in this example is summarised in (54).

- (54) $\text{MAX}[\text{close}], *[\text{close}, \text{RTR}] \gg \text{MAX}[\text{RTR}]$

This combination of faithfulness and markedness achieves the featural asymmetries defined by the contrastive feature hierarchy in Fig. 3.1b. As illustrated in the tableau in (55), the ranking in (54) will map any fully specified inputs to contrastively specified outputs. The ordering of feature-nodes in autosegmental representations in (55) mirrors the order of features in contrastive feature hierarchies (see Fig. 3.1b). In (55), the input is fully specified for both features, however according to the contrastive hierarchy in Fig. 3.1b,

[close] segments are non-contrastive for [RTR]. The faithful [close, RTR] /ɪ/ candidate in (a) therefore violates the high ranking *[close, RTR] co-occurrence constraint. Deleting [RTR] specifications on [close] segments as in candidate (b) produces a contrastively specified segment according to Fig. 3.1b and is optimal, violating only the low ranked MAX[RTR] constraint. Candidate (c) violates the high-ranked MAX[close] constraint and is eliminated.

(55) [RTR]-specifications are eliminated among [close]-segments

	MAX[close]	*[close, RTR]	MAX[RTR]
a.		*!	
b.			*
c.	*!		

This example provides a sample schematic of one simple way in which representational micro-cues can be grammatically implemented to produce representations consistent with contrastive feature hierarchies. The key insight is that there must be some explicit grammatical architecture defining a language's active phonological features and feature classes which interacts transparently (in derivational terms) with phonological processes. Contra Reiss' (2017, p. 26) claim that 'phonology doesn't "care" about contrast, because

it has no mechanism by which to do so,’ a version of the SDA incorporating contrast-defining representational micro-cues provides just such a mechanism.

3.2.2 The basics of harmony mechanisms

The nuts and bolts of a harmony mechanism are really quite simple. As we have seen above, to generalise the grammatical application of any harmony system, we need to specify at least two components: 1) what positions harmonise and 2) for what feature. For instance, the basic insights of Yoruba harmony can be captured by the simple licensing principle in (56) – adapted from Iosad (2017a, pp. 52–54) and Walker (2005) – which states that non-final vowels which are contrastive for the harmony feature [RTR] should be associated with [RTR] where possible. I assume a non-final vowel may satisfy this rule by being specified for [RTR] or by local feature spreading.

- (56) LICENSE(NON-FINAL-V–RTR, [RTR]):
 ‘Non-final vowels which are contrastive for [RTR] should be associated with [RTR]’

The licensing principle in (56) captures the basic insight of regressive (right-to-left) RTR harmony. It dictates that non-final, contrastively non-RTR segments are ‘needy’ in the sense of Nevins (2010) and will seek out [RTR]-feature specifications to copy from. Where there is no [RTR]-source to copy from, the harmony procedure comes up empty handed and no change occurs – resulting in ‘ATR’ harmony in Yoruba: for example, underlyingly non-RTR /ebè/ → [ebè] ‘heap of yams’ (35). On the other hand, if a local [RTR] feature is available, it spreads – resulting in RTR harmony: for example, /esè/ → [esè] ‘foot’.

This licensing account could be grammatically implemented in a wide variety of ways, and I do not commit to any one framework. In the way of an illustration, building on Mackenzie’s (2013, 2016) method of implementing contrastive hierarchies in OT constraint rankings, we could translate the harmony licensing principle in (56) to the more explicit [RTR]-licensing constraint defined in (57); cf. similar approaches in Downing & Mtenje (2017, ch. 4) and Harris (1994, 1997). $RTR \rightarrow [RTR]$ requires segments which are contrastive for [RTR] to be specified for [RTR]. Combined with MAX/DEP faithfulness constraints, this licensing constraint motivates feature spreading over feature insertion/deletion. I assume $RTR \rightarrow [RTR]$ competes with a lower ranked DEPLINK[RTR] constraint, which effectively penalises harmonic spreading. Specifically, DEP/MAXLINK constraints require input–output correspondents to preserve autosegmental associations (i.e. don’t insert or delete association lines); for further discussion, see Morén (2001), Blaho (2008), and Iosad (2017a). This approach provides an explicit representational account of how asymmetries in [RTR]/non-RTR specifications drives RTR harmony in Yoruba, limited by contrastive hierarchy representations.

(57) **Licensing and faithfulness constraints motivating RTR harmony**

- a. $RTR \rightarrow [RTR]$: Segments contrastive for [RTR] must be associated with [RTR].
- b. DEPLINK[RTR]: If an output segment x_o is linked to $[RTR]_o$, then its input correspondent x_i must be linked to $[RTR]_i$.

- c. DEP[RTR]: Assign a violation mark for any instance of [RTR] in an output that does not have an input correspondent.
- d. MAX[RTR]: Assign a violation mark for any instance of [RTR] in an input that does not have an output correspondent.

According to the contrastive hierarchy method, the basic grammatical machinery in RTR harmony is exactly the same across all Yoruba dialects, which differ only in their representations of close vowels. The mid and low vowel data in (58, 60) below are therefore generalisable across all Yoruba varieties. I assume any faithfulness/markedness constraints introduced by Mackenzie's (2013, 2016) algorithm in section 3.2 – e.g. the MAX[RTR] constraint from (55) – are ranked above the licensing/fidelity constraints defined in (57). For simplicity's sake, the examples below in (58, 60) concern only [RTR] feature specifications. The tableau in (58) illustrates the analysis with a root-final [RTR] vowel in [ɛsɛ] 'foot'. The tableau demonstrates how [RTR] faithfulness and licensing constraints in combination motivate RTR harmony spreading from final to non-final vowels.

(58) [RTR]-licensing in a constraint hierarchy

<div style="text-align: center;"> e sɛ̀ RTR RTR [RTR] </div>	MAX[RTR]	DEP[RTR]	RTR→[RTR]	DEPLINK[RTR]
a. <div style="text-align: center;"> e sɛ̀ RTR RTR [RTR] </div>			*!	
b. <div style="text-align: center;"> e sɛ̀ RTR RTR ‡ [RTR] </div>	*!		**	
c. <div style="text-align: center;"> e sɛ̀ RTR RTR ⋮ [RTR] [RTR] </div>		*!		*
d. <div style="text-align: center;"> e sɛ̀ RTR RTR ⋮ [RTR] </div>				*

The candidate in (a) [ɛsɛ] is faithful but not optimal since it bears a segment contrastive for [RTR] which is not associated with [RTR]. It thus violates RTR→[RTR] which motivates harmony. The surface-harmonic candidate (b) [ɛsɛ̀] illustrates that RTR→[RTR] cannot be satisfied by deleting the [RTR] feature since doing so violates the high-ranked MAX[RTR] constraint introduced by Mackenzie's (2013, 2016) algorithm in section 3.2. In a similar way, high-ranked DEP[RTR] motivates feature spreading over

feature insertion, as illustrated by candidate (c). Candidate (d) [ɛsɛ̀] is most optimal since it obeys both of the aforementioned faithfulness and licensing constraints by spreading [RTR] from the final to non-final vowel, violating only the low-ranked DEP_{LINK}[RTR] constraint.

The combination of representational constraints introduced by the SDA with the licensing constraint $RTR \rightarrow [RTR]$ establishes the first component of the Yoruba harmony process: what segments harmonise for what feature. The second component concerns the harmony domain: what positions harmonise? In Yoruba, low vowels in non-final syllables feature underlying [RTR]-specifications, as for example [abè] ‘crown’. In such cases, the non-final low vowel never assimilates to final vowels nor the other way around – leading to surface disharmony. Moreover, final vowels are strictly non-alternating with respect to tongue root harmony in Yoruba; there is no left-to-right harmony in Yoruba. In other words, the root-final syllable is a ‘prominent’ or ‘strong’ (trigger) position, which is exempt from the harmony licensing principle. This illustrates the need for a positional faithfulness constraint defined in (59) which prohibits [RTR] spreading from non-final to root-final positions. The combination of $RTR \rightarrow [RTR]$ and DEP_{LINK}[RTR]-σ# in effect penalises [RTR]-harmony spreading to the privileged, root-final position in Yoruba.

- (59) DEP_{LINK}[RTR]-σ#: If a syllable-final output segment x_o is linked to [RTR]_o, then its input correspondent x_i must be linked to [RTR]_i.

The effects of root-final positional faithfulness are demonstrated in the tableau in (60). For the sake of space, inactive constraints are not shown. In (60) the faithful candidate (a) [abè] is optimal over the harmonic candidate (b) [abè] since [RTR]-faithfulness is favoured over [RTR]-licensing in root-final positions. As we have seen before, there is no active ATR-harmony in Yoruba (i.e. candidate (c) [əbè]) since this would require [RTR]-delinking – violating high-ranked MAX[RTR] introduced by the SDA.

(60) **Positional faithfulness ensures non-advancing final syllables**

	<div style="text-align: center;"> a bè RTR RTR [RTR] </div>	MAX[RTR]	DEP _{LINK} [RTR]-σ#	$RTR \rightarrow [RTR]$	DEP _{LINK} [RTR]
☞ a.	<div style="text-align: center;"> a bè RTR RTR [RTR] </div>			*	
b.	<div style="text-align: center;"> a bè RTR RTR ↗ [RTR] </div>		*!		*
c.	<div style="text-align: center;"> a bè RTR RTR ‡ [RTR] </div>	*!		**	

In summary, the principal components of harmony processes are grammatically very simple. First, positional-restrictions on harmony domains can be easily achieved by ranking whatever relevant faithfulness constraints about whatever mechanism drives the harmony process. Second, assuming that faithfulness/markedness constraints introduced by the SDA have highest rank produces all typologically common categorical harmony behaviours (e.g. triggers, targets, transparent segments, blockers, etc.) as emergent effects of inventory-defining features and feature co-occurrence restrictions.

This latter insight is summarised by the tableaux in (61, 62) which incorporate all the relevant components outlined above in an illustration of Ifẹ Yoruba transparency and Standard Yoruba neutral blocking close vowels using the constraints outlined earlier in (55). This analysis shows that the neutrality (non-harmonisation) of [close] segments in both varieties is a product of the lack of permitted [close, (RTR)] /i, *ɪ/ contrasts. That is, the prohibition against *[close, RTR] co-occurrence which defines the Standard and Ifẹ Yoruba contrastive feature hierarchies in Fig. 3.1 prohibits harmonic spreading to [close] vowels, resulting in [RTR]-disharmonic Standard/Ifẹ Yoruba [igbé] ‘excrement’ (35, 43). Both dialects share the same set of active harmonising and non-harmonising vowels (e.g. /ɛ, e/ vs. /i/) but differ in the visibility of their non-harmonising [close] vowels, resulting in blocked [RTR]-harmony patterns in Standard Yoruba (e.g. [èlùbù] ‘yam flour’) vs. transparent skipping in Ifẹ Yoruba (e.g. [èlùbù]). These differences in the visibility of [close] segments to [RTR]-harmony is a simple, predicted effect of the relative scope of [RTR] and [close] features in contrastive feature hierarchies (see Fig. 3.1).

In the way of illustration, consider the tableau in (61) which illustrates the representational and grammatical constraints driving long-distance harmony in Ifẹ Yoruba. First, any faithfulness/markedness constraints introduced by Mackenzie’s (2013, 2016) algorithm are ranked high. The tableau in (61) therefore includes the MAX[close], *[close, RTR] » MAX[RTR] constraints introduced in (55). For the sake of space, inactive high-ranked DEP[RTR] and DEPLINK[RTR]-σ# are not shown in (61, 62) below. In Ifẹ Yoruba, [close] has broader scope while [RTR] has narrower scope. Given the broad scope of the [close] feature and co-occurrence restriction against *[close, RTR] vowels, [close] vowels are underspecified for [RTR] – lacking any **RTR** node. In (61), the faithful candidate (a) is disharmonic – violating the harmony licensing constraint **RTR**→[RTR] since it has an **RTR** node which is unassociated with an [RTR] specification. The harmonic candidate (b) satisfies the harmony licensing constraint by [RTR] spreading. Given that [close] vowels are underspecified for the harmony feature, they are not visible to local [RTR] spreading – resulting in transparency. Finally, candidate (c) illustrates that [RTR]-harmony cannot be satisfied by [RTR] deletion.

(61) Transparent [close] vowels in Ife Yoruba

<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> è CLOSE RTR </div> <div style="text-align: center;"> lù CLOSE [close] </div> <div style="text-align: center;"> bɔ́ CLOSE RTR [RTR] </div> </div>	Max[close]	*[close, RTR]	Max[RTR]	RTR→[RTR]	DEPLINK[RTR]
a. <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> è CLOSE RTR </div> <div style="text-align: center;"> lù CLOSE [close] </div> <div style="text-align: center;"> bɔ́ CLOSE RTR [RTR] </div> </div>				*!	
b. <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> è CLOSE RTR </div> <div style="text-align: center;"> lù CLOSE [close] </div> <div style="text-align: center;"> bɔ́ CLOSE RTR [RTR] </div> </div>					*
c. <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> è CLOSE RTR </div> <div style="text-align: center;"> lù CLOSE [close] </div> <div style="text-align: center;"> bɔ́ CLOSE RTR [RTR] </div> </div>			*!	**	

The situation in Standard Yoruba is quite similar. The harmony mechanism is identical; Standard and Ife Yoruba differ only in their inventory-defining faithfulness/markedness constraints introduced by the SDA, which follows from the alternative feature orderings in Fig. 3.1. Specifically, in Standard Yoruba the harmony feature [RTR] has broadest scope and [close] has narrower scope, resulting in the reversed order of high-ranking MAX[RTR], *[RTR, close] » MAX[close] constraints in (62). In contrast to Ife Yoruba above where [close] vowels are non-contrastively underspecified for [RTR] and therefore lack any **RTR**-node, Standard Yoruba [close] vowels are *contrastively non-specified* for [RTR]. In other words, [close] vowels are within the scope of [RTR] and therefore have an **RTR** feature-node in (62) below. This predicts that [close] vowels in Standard Yoruba should be associated with [RTR] according to RTR→[RTR]. Furthermore, since the **RTR** node defines harmony visibility, this account predicts close vowels should behave non-transparently with respect to [RTR] spreading in Standard Yoruba.

These predictions are born out in (62). In (62) the faithful candidate (a) is optimal – despite not being harmonic – since [RTR]-spreading would result in an illicit *[RTR, close] output, as in candidate (b). Following Mackenzie’s (2013, 2016) algorithm, each feature is introduced by a MAX constraint which outranks the RTR→[RTR] licensing constraint. A violation of *[RTR, close] introduced by [RTR]-harmony can therefore not be circumvented by deleting [close] as in candidate (c). Since feature-nodes define harmony spreading/landing sites, the fact that close vowels fail to undergo [RTR]-harmony in Standard Yoruba halts the process from spreading further downstream to the word-initial [RTR]-contrastive vowel /e/ – causing neutrally blocked surface patterns (i.e. blocked [èlùbɔ́], not transparent *[èlùbɔ́]).

(62) ***[RTR, close] neutral blocking in Standard Yoruba**

<div> <div> <div> <div>è</div> <div>RTR</div> <div>CLOSE</div> </div> <div> <div>lù</div> <div>RTR</div> <div>CLOSE</div> <div>[close]</div> </div> <div> <div>bó</div> <div>RTR</div> <div>[RTR]</div> </div> </div> </div>	MAX[RTR]	*[RTR, close]	MAX[close]	RTR→[RTR]	DEPLINK[RTR]
<div> <div> <div> <div>è</div> <div>RTR</div> <div>CLOSE</div> </div> <div> <div>lù</div> <div>RTR</div> <div>CLOSE</div> <div>[close]</div> </div> <div> <div>bó</div> <div>RTR</div> <div>[RTR]</div> </div> </div> </div>				**	
<div> <div> <div> <div>è</div> <div>RTR</div> <div>CLOSE</div> </div> <div> <div>lù</div> <div>RTR</div> <div>CLOSE</div> <div>[close]</div> </div> <div> <div>bó</div> <div>RTR</div> <div>[RTR]</div> </div> </div> </div>		*!			**
<div> <div> <div> <div>è</div> <div>RTR</div> <div>CLOSE</div> </div> <div> <div>lù</div> <div>RTR</div> <div>CLOSE</div> <div>[close]</div> </div> <div> <div>bó</div> <div>RTR</div> <div>[RTR]</div> </div> </div> </div>			*!		**

This sketch of Ifẹ Yoruba and Standard Yoruba neutral harmony patterns illustrates how the representational insights of the contrastive hierarchy method can be incorporated into an explicit grammatical model. The important insight is that constraints on phonological representations introduced in the course of phonological acquisition limit whatever grammatical mechanism spreads harmony between segments contrastive for the harmony feature. Consistent with other contrastive hierarchy methods, this approach posits that narrow variation in phonological visibility is predicted by variable feature ordering, as illustrated by the above contrasting neutral blocking and transparency patterns in Standard and Ifẹ Yoruba, respectively.

3.3 Feature scope and non-/conditional harmony

The architecture outlined above is adequate for tackling all typologically common forms of non-conditional harmony and harmony neutrality; that is, systems with categorical classes of harmonising and neutral segments. Specifically, asymmetric inventory shape in the way of harmonically unpaired segments motivates distinct harmony and neutral harmony asymmetries, such as the cross-dialectal varied RTR harmony behaviour of Yoruba close vowels /i, u/ in target positions, summarised in Table 3.1. The organisational principles of the contrastive hierarchy method explicitly predict this basic ternary typology in potential target behaviours: [close] distinctions are either within or outside the scope of [RTR] distinctions, and [RTR, close] co-occurrence is either permitted or not, producing (visible / active) harmonising targets as in Ekiti Yoruba, (visible / inactive) blockers as in Standard Yoruba, and (invisible / inactive) transparent segments as in Ifẹ Yoruba. There are no ‘dark

matter’ segments which are simultaneously invisible but active. These would be segments which trigger harmony in trigger positions but which are transparent to harmony in target positions. Such invisible but active segments are ruled out since activity with respect to a feature [F] guarantees visibility to processes which compute [F].³ In sum, the combination of feature scope and specificational asymmetries afforded by the contrastive hierarchy predicts the basic ternary typology of harmony behaviours in Table 3.1. If it is correct that the harmony procedure applies to representations resembling contrastive feature hierarchies, then regardless of whatever grammatical mechanism drives harmony, it will produce the categorical harmony and neutral harmony effects observed in Table 3.1.

Table 3.1: Harmony target behaviours via variable feature scope and co-occurrence constraints

	Feature order	Co-occurrence	Recipient behaviour type		
a.	[RTR] > [close]	[RTR, close]	èlùbù	harmonic	Ekiti Yoruba
b.	[RTR] > [close]	*[RTR, close]	èlùbù	blocking	Standard Yoruba
c.	[close] > [RTR]	*[RTR, close]	èlùbù	transparent	Ifè Yoruba

The table above accurately summarises the behavioural possibilities of neutral segments which categorically never undergo harmony. There are however harmony systems with more intricate restrictions on harmony patterns; cases where segments are *sometimes* harmonic and *sometimes* not. This is found in so-called ‘parasitic’ harmony systems where harmonisation for one feature [F] (the ‘parasitic’ feature) is dependent on agreement for some other ‘host’ feature [G]. In such languages, [G]-segments will undergo [F]-harmony but only with other [G]-specified segments. In all other cases, harmony fails to apply. For example, as illustrated by the Chewa (N.31) data in (63) below, harmonic lowering in canonical Bantu height harmony is partially dependent on trigger/target agreement for labiality (Downing & Mtenje 2017). In other words, [labial] vowels will only harmonise for height with other [labial] vowels and are otherwise neutral: e.g. labial and height disharmonic [tsék-ul-a], *[tsék-ol-a] vs. labial and height harmonic [wónj-ol-a]. In some form then, [open]-harmony is dependent on agreement for [labial] in Chewa.

(63) **Chewa labial/non-labial asymmetries in height harmony**

a. Non-conditionally harmonising non-labial applicative /-il/

HIGH	phík-il-a	‘cook’	túm-il-a	‘send’
NON-HIGH	tsék-el-a	‘close’	gón-él-á	‘sleep’

b. Conditionally harmonising labial reversive /-ul/

HIGH	pítíks-ul-a	‘overturn’	fúnth-ul-a	‘loosen’
NON-HIGH	tsék-ul-a	‘open’	wónj-ol-a	‘spring a trap’
	*tsék-ol-a			

³These definitions do not only apply to segments; featural affixes or morphological tone – though they are free (floating) – are not counterexamples to this generalisation. For example, the [nasal] marker of the 1st person in Terena, an Arawakan language of Brazil which displays nasal harmony (Bendor-Samuel 1960, 1966), is by definition both active (featurally specified [nasal]) and visible (displays overt participation in nasal harmony): e.g. [ajo] ‘his brother’ vs. [ãjõ] ‘my brother’.

We have seen ample evidence that *non-contrastivity* for the harmony feature guarantees neutrality in harmony systems, but parasitic or conditional harmony like that found in Chewa shows that the opposite does not in all cases hold: *contrastivity* for a feature does not necessarily guarantee harmony. Though all the vowels in /i, u, e, o/ in (63) must be contrastive for the harmony feature given that they undergo harmony in at least some context, non-open /u/ fails to harmonise with [open] /e/. Why this is the case and what motivates conditional harmony systems like Chewa remains one of the most enigmatic areas of vowel harmony research. Such conditional or parasitic asymmetries are not predicted by the majority of harmony frameworks, and ad hoc limitations on feature-similarity are common in the harmony literature. For example, in the treatment of canonical Bantu parasitic harmony systems, Moto (1989) assumes harmony triggers are only permitted to spread [–high] to targets specified as [–round, –low] with the exception that [+round] triggers can only spread to targets specified as [+round, –low]. Mutaka (1995, pp. 43–44) and Hyman (1991) use a similarity/parasitic stipulation. Nevins (2010, pp. 130–33) treats front and back height harmony as distinct harmony processes, where only back height harmony is limited by [+round]-similarity. Others assume parasitic height harmony is limited by a functionally motivated markedness constraint against non-high, round vowels (i.e. *[RoLo]; e.g. Beckman 1997 and Nichols 2018), but such techniques are not obviously generalisable to other, non-height parasitic harmony systems. Finally, others note but do not tackle these parasitic asymmetries: e.g. Harris (1994) or Downing & Mtenje (2017). It is safe to say that parasitic harmony systems, while very common, are poorly understood.

Building on the contrastive hierarchy method, I propose a novel approach. Namely, parasitic harmony displays a nesting relationship between phonological features where one feature depends on another. As I demonstrate in the remaining sections, this asymmetric feature dependence relationship is predicted by the contrastive hierarchy architecture. Specifically, the presence or absence of [F]-harmony conditions on orthogonal [G]-feature agreement are captured by [F] / [G] feature scope asymmetries. Under this account, harmony for [F] is limited by harmony-recipients' higher scope feature specifications, such that a parasitic feature ordering [G] > [F] produces [F]-harmony which is dependent on [G] agreement while a non-parasitic ordering [F] > [G] produces symmetric, non-parasitic [F]-harmony which is not dependent on [G] agreement. In the remaining sections, I explore the nature and patterning of conditional or parasitic harmony systems and demonstrate that the contrastive hierarchy method provides the right architecture for a unified representational analysis of both conditional and non-conditional types of neutral harmony.

3.3.1 Contrasting conditional and non-conditional harmony

To provide a more concrete illustration of parasitic and non-parasitic harmony asymmetries, let us compare two languages whose harmony systems differ specifically with respect to the presence or absence of parasitic conditions. An example of a non-parasitic harmony system is provided in (64) by Mongo-Nkundo, Lonkundo, or simply Nkundo (C.60), a Bantu language spoken in the Democratic Republic of the Congo; described by (Hulstaert 1961, pp. 16–17) as cited by (Leitch 1996, p. 63). In Nkundo, tongue root harmony is fully symmetric, with both prefixes and suffixes harmonising to root-initial syllables (64). For

ease of comparison with the more complex parasitic harmony system below, ATR/RTR surface patterns in these data are highlighted via colouring. All mid vowels, regardless of secondary features, can harmonise to all other mid vowels in Nkundo.

(64) **Symmetric RTR harmony in Mongo-Nkundo (C.6o)**

- | | | | | | |
|----|-------------------|-----------------|----|------------------------------------|-----------|
| a. | bo-k <u>o</u> ngo | ‘copalier’ | e. | b <u>o</u> -k <u>o</u> ng <u>o</u> | ‘dos’ |
| b. | lo-f <u>o</u> so | ‘peau’ | f. | l <u>o</u> -f <u>o</u> s <u>o</u> | ‘bruit’ |
| c. | e-k <u>e</u> le | ‘impossibilite’ | g. | ε-k <u>e</u> le | ‘nain’ |
| d. | bo-k <u>e</u> le | ‘oeuf’ | h. | b <u>o</u> -k <u>e</u> le | ‘liquide’ |

Kikuyu (E.51; aka Gikuyu), spoken in Kenya, Tanzania, and Uganda, displays a similar RTR harmony system, spreading from root-initial to non-initial syllables: e.g. [RTR] [hooŋɔr-a] vs. non-RTR [θooŋɔr-a] (Armstrong 1940, Peng 2000). Unlike Nkundo, however, harmony patterns in Kikuyu are asymmetric. In Kikuyu, not all vowels are equally viable harmony triggers – specifically, though non-round vowels assimilate to round vowels in Kikuyu, the opposite does not occur – round vowels do not assimilate to non-round vowels. Correspondence for [RTR] is limited by [labial] feature specifications, and this neutral harmony pattern displays a marked/unmarked asymmetry. Though non-labial targets are not ‘picky’ and can assimilate to either [labial] or non-labial vowels – e.g. [RTR] [hooŋɔr-a] and [βεrɛr-a] – the disharmonic form [kεrɔr-a] in (65) shows that non-labial/unmarked /ε/ is not capable of retracting following [labial]/marked vowels. Kikuyu is an example of parasitic harmony just like we saw in Chewa height harmony in (63) above. In Kikuyu, RTR harmony is in some fashion contingent or *parasitic* on some orthogonal feature – in this case [labial] – leading to asymmetries in RTR harmonic [ɔ...ɔ] but RTR disharmonic [ε...o] sequences.

(65) **Parasitic RTR harmony in Kikuyu (E.51)**

V ₁ (↓) / V ₂ (→)	LABIAL	NON-LABIAL
LABIAL	<u>o</u> roor-a ‘roam’	θ <u>o</u> oŋɔr-a ‘protrude’
	k <u>o</u> rɔr-a ‘cough’	h <u>o</u> oŋɔr-a ‘be dented’
NON-LABIAL	r <u>ε</u> βor-a ‘expel, shake out’	c <u>ε</u> rek-a ‘squirt’
	k <u>ε</u> rɔr-a ‘empty or drain out’	β <u>ε</u> rɛr-a ‘break, crush’
	*k <u>ε</u> rɔr-a	

Non-initial vowels, regardless of their labiality, are harmonic following round vowels. In other words, [labial] vowels are universal triggers, as illustrated in the top half of (65). These ATR / RTR alternations provide irrefutable evidence that all mid vowels must be contrastively specified and non-specified for the harmony feature – i.e. **RTR**[RTR] /ε, ɔ/ and **RTR**[] /e, o/ – since they are all harmonic triggers/targets of [RTR]-harmony in at least some domain. The harmony exception in [ε...o] sequences – i.e. non-harmonising /o/ or non-triggering /ε/ – is not predictable from the behaviour of /ε, e/ or /ɔ, o/ vowels in other contexts. It is specifically at the intersection of V₁-non-labial and V₂-[labial] vowels in which harmony fails to apply, as illustrated below in (66).

(66) Asymmetric RTR harmony parasitism

V ₁ (↓) / V ₂ (→)		LABIAL [-or] / [-ɔr]	NON-LABIAL [-er] / [-ɛr]
LABIAL	/ɔ/	ɔ-ɔr	ɔ-ɛr
NON-LABIAL	/ɛ/	ɛ-or	ɛ-ɛr

Conditional neutrality like that observed above in Kikuyu is uniquely different from the other forms of disharmony we have considered thus far. In all previous cases of neutral harmony which we have seen in Yoruba and other harmony languages, the disharmonic patterns are categorical/non-conditional and all correlate with some discrete inventory asymmetry. In Kikuyu, we have examples of both types of harmony neutrality: conditional neutrality-by-parasitism in mid vowels which displays marked/unmarked asymmetries and categorical/non-conditional neutrality-by-inventory-asymmetry in high/low vowels. As shown in (67) below, Kikuyu low vowels for example *never* undergo or trigger vowel harmony and *always* neutrally block RTR harmony in non-initial positions: e.g. [ɔy-an-ok-a], *[ɔy-an-ɔk-a]. In other words, low vowels are unconditionally neutral and are never valid recipients nor donors of the harmony feature – regardless of [labial]-specifications. Kikuyu low /a/ displays the exact same behaviour as neutral close vowels in Standard Yoruba, which can be captured using the same techniques in Table 3.1b; i.e. low vowels may be construed as categorically non-harmonising targets in Kikuyu due to a *[RTR, low] co-occurrence restriction which bars both an */a, ə/ contrast and low vowel RTR harmony patterns.

(67) /a/ is a [RTR]-neutral blocking in Kikuyu

Trigger positions			Target positions		
a.	h <u>a</u> t-ek-a	‘squeeze’	e.	tɛt-an-er-a	‘speak for’
b.	β <u>a</u> θ-er-ek-a	‘become rich’	f.	ɛt-an-er-a	‘call for’
c.	y <u>a</u> r-or-a	‘turn round’ (<i>trans</i>)	g.	ɔy-an-ok-a	‘bring down’
d.	t <u>a</u> h-or-a	‘undo the act of scooping’	h.	t <u>o</u> m-an-or-a	‘undo the act of sending for’

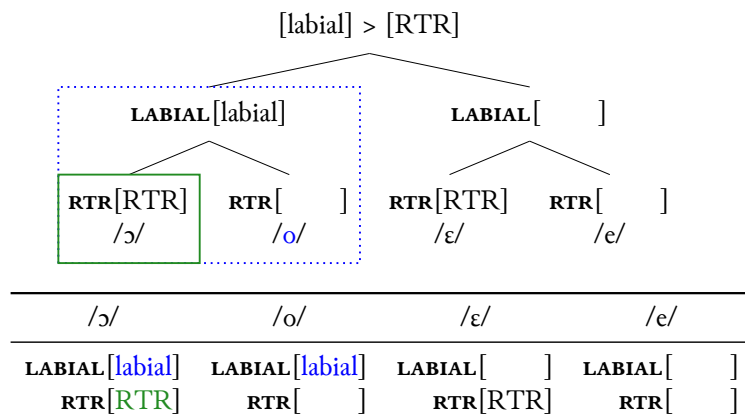
In summary, the behaviour of low and mid vowels is very different in Kikuyu. In contrast to low vowels, mid vowels in Kikuyu sometimes harmonise, as in [βɔk-ɔr-a], but other times do not, as in [kɛrɔr-a]. Conditional harmony neutrality like this must be cross-linguistically optional, as illustrated by the comparison with non-parasitic Nkundo RTR harmony above. We know that all /ɛ, e, ɔ, o/ are contrastively specified and non-specified for [RTR] in both languages, but feature-specification does not ensure harmony correspondence. The conditional neutral behaviour of Kikuyu mid vowels despite being demonstrably contrastive for the harmony feature therefore has important implications for the nature of harmony processes and the relation between harmony and orthogonal phonological features.

3.3.2 Parasitic harmony as feature parasitism

I argue non-/parasitic harmony asymmetries reflect a universal limitation on harmony processes; namely, harmonisation is limited by harmony-recipient subsegmental feature specifications. In his treatment of parasitic systems in particular and vowel harmony in general, Nevins (2010) has demonstrated that harmony generalisations are most economically definable over harmony-recipients or targets rather than harmony-donors or triggers. As we have seen in the Kikuyu examples above, being specified for a feature in harmony trigger positions – e.g. [RTR] /ε/ – does not guarantee feature-spreading – e.g. [yɛt-or-a], *[yɛt-ɔr-a]. For this reason, harmony analyses often resort to stipulative restrictions on feature-spreading of the type: ‘a trigger *x* spreads feature [F] to a recipient *y* **unless** *y* is specified [G]’. That is, harmony generalisations necessarily make reference to target- or recipient-structure. For instance, in Kikuyu, a root-initial /ε/ spreads [RTR] to a non-initial vowel *y* unless *y* is specified [labial]; for [labial] root-initial vowels, RTR harmony is unconstrained.⁴ This parasitic stipulation in effect divides vowel harmony in Kikuyu into two processes with distinct conditions on labial RTR harmony which do not apply to non-labial RTR harmony.

There are a number of obvious undesirable results of this kind of approach. Parasitism-by-stipulation is only a restatement of the facts and fails to explain important recurring patterns. Parasitic harmony systems typically display a conspicuous marked/unmarked asymmetry on harmony-recipients. This asymmetry is already baked into the structure of privative contrastive feature hierarchies. For instance, in Kikuyu RTR harmony, [labial] vowel targets fail to harmonise to non-labial vowels, but the reverse is never the case. Assuming harmonisation for [RTR] is limited by a harmony-recipient’s higher-scope feature specifications, then [labial] /o/ can only harmonise with [RTR, labial] /ɔ/ in Kikuyu. This is outlined by the different marked/unmarked feature scopes in the Kikuyu mid vowel contrastive feature hierarchy in Fig. 3.4. The blue and green boxes in Fig. 3.4 and Fig. 3.5 below outline each harmony recipient’s possible [RTR]-feature donor/s as limited by their higher marked feature specifications. The contrastive hierarchies below consider only mid vowel contrasts; see section A.6 in the appendix for full vocalic representations.

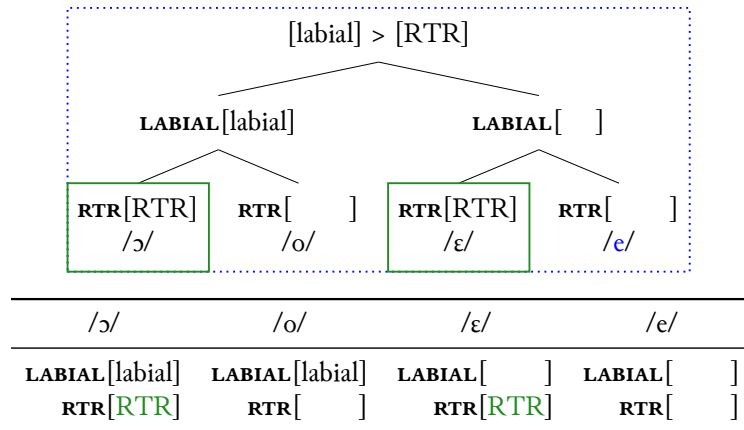
Figure 3.4: [RTR] is parasitic on [labial] in Kikuyu (E.51)



⁴For similar parasitism-by-stipulation accounts of both Bantu tongue root and/or height harmony, see for example Moto (1989); Hyman (1991); Mutaka (1995); Peng (2000); and Nevins (2010, pp. 130–33).

Assuming harmonisation is limited by harmony-recipients' higher-scope feature specifications predicts that parasitic harmony systems should display a marked/unmarked asymmetry because of the privative nature of phonological features (see section 2.2.1). In other words, featurally more complex or more marked harmony recipients set stricter limits on feature-donors than less marked recipients. In this case, [labial] /o/ can only copy from [labial] /ɔ/ in Kikuyu – e.g. [kɛrɔr-a], *[kɛrɔr-a] – but less marked (non-specified) non-round vowels – which lack higher-scope feature specifications – set no restrictions on where their [RTR] feature specifications come from, copying from both [RTR, (labial)] /ɛ, ɔ/: e.g. [RTR] [βɛrɛr-a] and [hɔɔnder-a], not *[hɔɔnder-a]. The reverse case where vowels of the unmarked set (in this case non-round vowels) can only copy from other unmarked, non-round vowels while marked, labial vowels are unrestricted is not attested. This asymmetry is schematised in Fig. 3.5. [labial] /o/ can only copy from [labial, RTR] /ɔ/ whereas non-labial /e/ displays no harmony condition on [labial]-agreement since it is non-specified for [labial], as illustrated below in Fig. 3.5.

Figure 3.5: Featurally less marked segments are non-selective harmony recipients



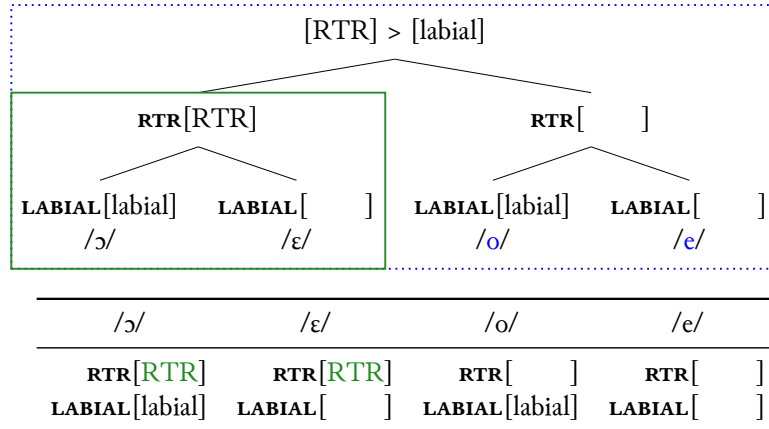
While other approaches to harmony require ad hoc stipulations to stop [RTR]-specified /ɛ/ from spreading to /o/, a recipient-oriented account wherein the harmony procedure is limited by recipient feature specifications naturally predicts the right asymmetries. Assuming harmony-recipients can only copy [RTR] from donors which share their feature-specifications (i.e. donors within their respective specified-feature domains, as illustrated in Figs. 3.4, 3.5), then the right [labial]/non-labial harmony asymmetries emerge in contrastive feature hierarchies where the harmony feature [F] has narrower scope (is parasitic on) some orthogonal feature [G], as in Kikuyu ([labial] > [RTR]).

3.3.3 Non-parasitic harmony as feature non-parasitism

Both parasitic and non-parasitic harmony systems receive a unified treatment following a contrastive hierarchy approach via simple feature scope asymmetries. As illustrated in Fig. 3.4/3.5, [RTR] has narrower scope than [labial] in Kikuyu, resulting in parasitic or asymmetric harmony where [labial] vowels can only copy [RTR] from other [labial] vowels while less marked non-round vowels can copy [RTR] from any feature-source. But since any harmony procedure for a feature [F] is only limited by feature-specifications which

precede [F] in the contrastive feature hierarchy, symmetrical or non-parasitic harmony is predicted by simple $[F] > [G]$ and $[G] > [F]$ feature-ordering differences.

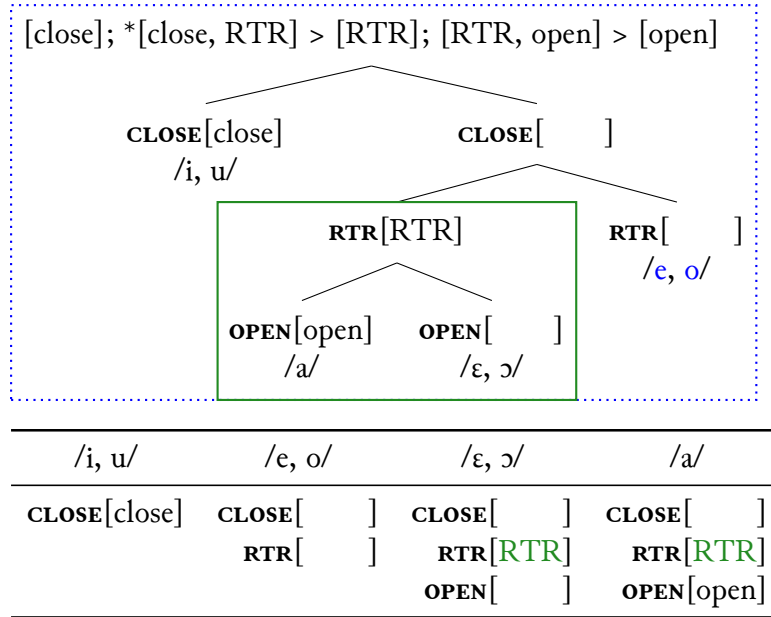
Figure 3.6: [RTR] is not parasitic on [labial] in Nkundo (C.6o)



For instance, in Nkundo [RTR]-harmony applies symmetrically to both [labial] and non-labial vowels. This is achieved by ranking [RTR] over [labial], as in Fig. 3.6. In this case, [RTR] has broadest scope. If it is correct that harmony for [RTR] is only limited by broader scope feature specifications, then this feature ordering predicts that both [(labial)] /o, e/ are equally valid harmony-recipient of either [RTR, (labial)] /ɔ, ɛ/ in Nkundo since [RTR] is not dependent/parasitic on [labial]. This account provides a non-stipulative treatment of parasitic and non-parasitic harmony systems using only the existing contrastive hierarchy architecture. Under this account, all harmony languages are ‘parasitic’ insofar as harmony is limited by harmony-recipient broader-scope feature specifications. Whether surface harmony patterns displays parasitic-asymmetries or not is predicted to be a simple effect of the ordering of harmony and orthogonal features. Construing harmony parasitism as feature parasitism does not involve any additional ad hoc, language-particular restrictions on harmony application but instead capitalises on independently motivated representational principles.

We can demonstrate this insight by considering a familiar contrastive hierarchy for a clearly non-parasitic harmony language, such as Yoruba. The choice of Yoruba dialect does not matter, but for the sake of illustration I provide the Ife Yoruba oral vowel contrastive hierarchy in Fig. 3.7, reproduced from Fig. 3.2b. The contrastive hierarchy in Fig. 3.7 predicts correctly that Ife Yoruba [RTR]-harmony patterns will not display any parasitic asymmetries. This is so because the only contrastively non-specified non-RTR harmony-recipients /e, o/ in Yoruba do not bear any marked feature specifications above the scope of [RTR]. Put another way, Yoruba is like Nkundo, featuring symmetric [RTR]-harmony with no overt orthogonal feature conditional asymmetries.

Figure 3.7: Ife Yoruba harmony donor/recipient feature-scope



These comparisons of parasitic and non-parasitic harmony systems illustrate how the contrastive hierarchy framework provides for the right non-/parasitic asymmetries assuming harmony is universally restricted by recipient subsegmental structure. Parasitic feature ordering effects on harmony are not, however, simply an accidental effect of the representational architecture. I argue that the existence of parasitic harmony effects plays a broader role in defining and generalising phonological representations. The presence or absence of parasitic asymmetries provide an additional explicit heuristic to speakers for learning and generalising non-ambiguous segmental representations and particularly dominant/dependent feature relations, many of which would be lacking if the harmony systems were not inherently limited by feature scope asymmetries. I leave for future work a more explicit grammatical formalisation of parasitic feature ordering effects on harmony systems, but the key insights outlined here provide the beginnings of a much more robust contrastive hierarchy methodology which makes much more concrete the roles which inventory shape and relative feature scope play in phonological patterning. In the following sections, I explore further implications of parasitic and non-parasitic asymmetries in harmony systems and demonstrate clear diagnostics for identifying parasitic vs. non-parasitic types of harmony neutrality.

3.3.4 Parasitism in dual harmony systems

Since parasitic effects are a result of relative feature scope, dual harmony systems which display multiple [F]/[G] harmony features may (and often do) display differing harmony asymmetries in [F] vs. [G] harmony. This is so because given two harmony features, one feature must be dominant or dependent on the other. For example, Yakut (also known as Sakha), a Siberian-Turkic language spoken in the Sakha (Yakutia) Republic in Russia, displays overlapping backness and labial harmony, resulting in a four-way contrast – e.g. [e, ø, a, o] (Krueger 1962, pp. 46–53).

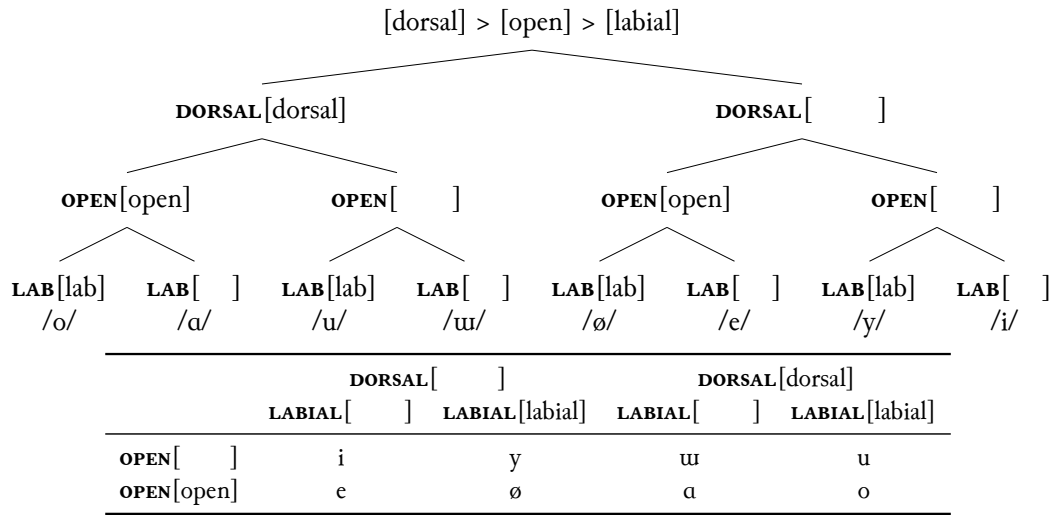
(68) **Yakut high vowels are harmony recipients but invalid harmony donors**

- | | | | |
|-----------------------------|---------------------|-----------------------------|---------------------|
| a. k _{el} -el-ler | ‘come’-3.PRES.-PL. | e. k _{el} -li-ler | ‘come’-3.PRET.-PL. |
| b. k _{ør} -øl-lør | ‘see’-3.PRES.-PL. | f. k _{ør} -dy-ler | ‘see’-3.PRET.-PL. |
| c. b _{ar} -al-lar | ‘go’-3.PRES.-PL. | g. b _{ar} -du-lar | ‘go’-3.PRET.-PL. |
| d. o _{lor} -ol-lor | ‘dwell’-3.PRES.-PL. | h. o _{lor} -du-lar | ‘dwell’-3.PRET.-PL. |

However, backness and labial harmony display certain asymmetries in Yakut. As illustrated in (68), all vowels are harmonic with respect to backness harmony, but labial harmony is more complex. In Yakut labial harmony, high vowels (the unmarked class) are always harmonic, assimilating to both high and non-high vowels. However, the reverse is not the case; non-high vowels /a, e/ harmonise only to other non-high vowels – e.g. [k_{el}-el-ler] vs. [k_{ør}-øl-lør] – and are labially disharmonic following high vowels, as illustrated by the plural suffix /-ler/ in (68e–h): [o_{lor}-du-lar], *[o_{lor}-du-lør]. This is the exact reverse of Chewa patterns we observed in (63) above. Where [open]-harmony is parasitic on [labial] in Bantu height harmony systems, [labial]-harmony is parasitic on [open] in Yakut.

With respect to backness harmony, I assume the marked/unmarked feature asymmetries is [dorsal] /a, o, u, ʊ/ vs. non-dorsal /e, ø, i, y/. Since backness harmony is fully symmetric (that is, not dependent on other vocalic features), [dorsal] must have broadest scope: i.e. [dorsal] > {open/labial}. But given that [labial]-harmony patterns are dependent or parasitic on [open], we can infer the feature-ordering [open] > [labial]. According to this parasitic feature ordering, non-initial [open] vowels can only copy [labial] from other [open] vowels. In sum, Yakut harmony patterns indicate the representations in Fig. 3.8 where [dorsal] has broadest scope and [labial] has narrowest.⁵

Figure 3.8: Yakut contrastive feature hierarchy



⁵This parasitic pattern is stable in Yakut, being attested already in the earliest reliable 18th- and 19th-century grammatical descriptions (e.g. Pallas 1811; cf. Károly 2008).

3.3.5 Parasitism is iteratively blocking

I have posited that harmony processes are strictly local, and locality domains are defined by feature-nodes introduced by the SDA. This predicts that harmony applies iteratively; spreading from syllable to syllable with the affixation of each additional morpheme. This iterativity makes the interesting prediction that parasitic harmony should be iteratively blocking, and this prediction is confirmed by parasitic blocking effects in trisyllabic labial harmony in Yakut in (69).

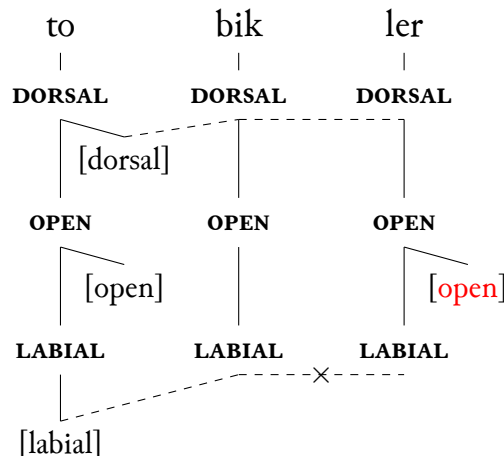
As shown in Fig. 3.8, less marked (non-open) high vowels are not picky labial harmony recipients and harmonise with either [(open)] vowels (e.g. open/non-open /øris/ → [ørys], *[øris]). However, [open] vowels can only assimilate to other [open] vowels (69). The successive affixation of the [open] plural suffix /-ler/ to high final-vowel roots in (69) therefore results in labial harmony blocking (e.g. /ørys-ler/ → [ørys-ter], *[ørys-tør]).⁶ This is an example of blocking by feature-parasitism.

(69) Yakut harmony blocking following height dissimilar disyllabic roots

- | | | | |
|----|--------------------|---------------|---------------------|
| a. | t o buk-tar | ‘knee’-PL. | *t o buk-tor |
| b. | o y us-tar | ‘bull’-PL. | *o y us-tor |
| c. | o j u:r-dar | ‘forest’-PL. | *o j u:r-dor |
| d. | ørys-ter | ‘river’-PL. | *ørys-tør |
| e. | bøly:k-ter | ‘rooster’-PL. | *bøly:k-tør |

This blocking pattern is represented in (70). High vowels undergo labial and backness harmony as in [t**o**buk], *[t**o**buk], but since harmony is inherently limited by the recipient’s higher-scope features, harmony fails to apply to following [open] vowels which cannot assimilate to non-open vowels. High vowels lack the necessary [open]-specification: e.g. *[t**o**buk-tor]. Given that high vowels are contrastive for the harmony feature and bear a **LABIAL** feature-node, they are *visible* but *invalid* feature-donors to [open] vowels. Even though a valid feature-source such as the [open] /o/ vowel may occur further downstream, harmony cannot skip **LABIAL**-contrastive vowels, regardless of their [(open)]-specifications.

(70) Labial harmony blocking by [open]-parasitism: [tobuktar]



⁶Note that /l/ occludes and assimilates for voicing following non-lateral consonants in Yakut; cf. [l]-forms in lateral and vocalic environments in (68) – e.g. [kɛl-li-ler] ‘come’-3.PRET.-PL.

In comparison to these intricate [labial] harmony patterns, [dorsal]-harmony is non-parasitic in Yakut. In other words, since [dorsal] has broadest scope, it applies symmetrically across all vowels, as illustrated in (70). Though [open] vowels cannot assimilate to non-open vowels for the narrower-scope feature [labial] they do harmonise for the broader scope [dorsal] feature. This example provides therefore a concise illustration of parasitic and non-parasitic harmony in one and the same language.

3.3.6 True vs. false parasitism

I have argued that true parasitic harmony systems occur when the harmony feature [F] has narrower scope than some feature [G] – resulting in asymmetric [F]-harmony patterns among [G]- vs. non-specified segments. Not all languages which have traditionally been called ‘parasitic’ meet this definition. Like Yakut, Turkish displays similar overlapping labial and backness harmony. This results in the familiar four-way rounding/backness alternations in (71), as exemplified by the genitive suffix [-in, -yn, -un, -ün]. Turkish labial harmony is commonly described as being ‘parasitic’ like Yakut insofar as labial harmony targets are strictly high vowels (Clements & Sezer 1982, Kabak 2011); non-high /ε, a/ vowels fail to harmonise to [ø, o] in labial harmony. Non-high Turkish vowels do not display corresponding four-way labial/backness alternations, despite the apparent symmetry of traditional representations of Turkish vowels in Table 3.2. For consistency with the Yakut data above, I represent Turkish vowel distinctions using IPA rather than orthographic symbols, as outlined in Table 3.2.

Table 3.2: Turkish vowel phonemes

		FRONT		BACK	
		NON-ROUND	ROUND	NON-ROUND	ROUND
HIGH	i		ü (y)	ɪ (u)	u
LOW	e (ε)		ö (ø)	a (ɑ)	o

Though the patterns in (71) are similar to those found in Yakut, there is a crucial difference. While /ε, a/ undergo rounding harmony in Yakut *sometimes*, non-high suffixes in Turkish undergo rounding *never*, an indication of false parasitism. Turkish non-harmonising [ε, a] vowels lack the tell-tale sign of feature parasitism: marked/unmarked asymmetries resulting from nested feature contrasts. In Yakut, height-disimilar [ørys-ter] is labially disharmonic while height harmonic [kør-øl-lør] is labially harmonic. In Chewa, backness-dissimilar [tsék-ul-a] is height disharmonic, but backness-similar [wónj-ol-a] is height harmonic. In Turkish, height-similarity makes no difference in labial harmony. Non-high suffixes categorically fail to undergo rounding regardless of the relative height of preceding vowels: e.g. uniformly disharmonic high [pul-lar-un] and non-high [jol-lar-un], *[jol-lor-un]. Turkish low vowels are universally illicit recipients of [labial]-harmony in Turkish, functionally equivalent to the other examples of (non-parasitic) neutral blocking we have seen in Standard Yoruba high vowels, Chewa low vowels, and Kikuyu low vowels.

(71) Turkish overlapping front/back and rounding harmony

	NOM.SG.	GEN.SG.	PL.-GEN.		
Non-Round + front	ip	ip-in	ip-ler-in	‘rope’	
Non-Round + back	k <u>u</u> z	k <u>u</u> z-un	k <u>u</u> z-lar-un	‘girl’	
Round + front	y <u>y</u> z	y <u>y</u> z-yn	y <u>y</u> z-ler-in	‘face’	*y <u>y</u> z-ler-yn, *y <u>y</u> z-lør-yn
Round + back	p <u>u</u> l	p <u>u</u> l-un	p <u>u</u> l-lar-un	‘stamp’	*p <u>u</u> l-lar-un, *p <u>u</u> l-lør-un
Non-Round + front	j <u>e</u> r	j <u>e</u> r-in	j <u>e</u> r-ler-in	‘place’	
Non-Round + back	j <u>a</u> f	j <u>a</u> f-un	j <u>a</u> f-lar-un	‘age’	
Round + front	s <u>ø</u> z	s <u>ø</u> z-yn	s <u>ø</u> z-ler-in	‘word’	*s <u>ø</u> z-ler-yn, *s <u>ø</u> z-lør-yn
Round + back	j <u>o</u> l	j <u>o</u> l-un	j <u>o</u> l-lar-un	‘road’	*j <u>o</u> l-lar-un, *j <u>o</u> l-lør-un

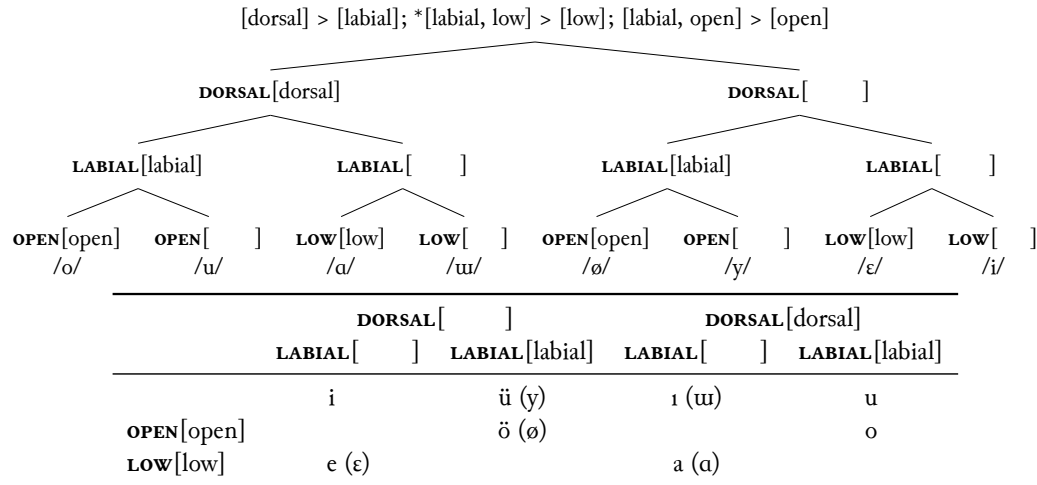
These patterns contradict the traditional two-height symmetric featural interpretations in Table 3.2. There is no phonological evidence that the Turkish vowel inventory is so symmetric. If / ϵ , α / were in fact featurally paired for rounding with / \emptyset , o /, we would expect these vowels to undergo harmonic alternations in at least some contexts. In target positions, we find no non-high labial alternations and underlying / o , \emptyset / are strictly non-harmonising, as demonstrated by the famous ‘half-harmonising’ Turkish progressive suffix /-ijor/ in (72). This suffix is made up of a harmonising target /i/ and a non-alternating / o / which triggers [dorsal, labial] harmony on following suffixes, as evidenced by the following 1.SG. suffix in (72).

(72) Half-harmonising Turkish progressive suffix /-ijor/

- a. gil-i-jor-um ‘come’-PROG.-1.SG. *gil-i-jir-im
- b. gyl-y-jor-um ‘laugh’-PROG.-1.SG. *gyl-y-jør-ym
- c. kof-u-jor-um ‘run’-PROG.-1.SG.
- d. bak-u-jor-um ‘look’-PROG.-1.SG. *bak-u-jar-um

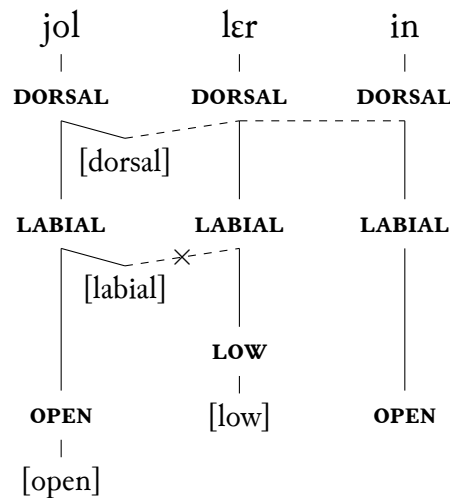
These facts reveal that Turkish vowels are divisible into three vowel heights: [open] vowels / \emptyset , o /, [low] vowels / ϵ , α /, and close (height non-specified) /i, y, u, u /. The active harmony features in Turkish are [dorsal] and [labial] with a *[labial, low] co-occurrence restriction, evidenced by plural suffix /-ler/ neutral blocking patterns in (71). [dorsal, labial, open] / o / being specified for both harmony features is a universal feature-donor and therefore non-alternating, as shown in (72). Turkish /i/ being contrastively non-specified for both features is a universal feature-recipient and therefore a non-trigger: e.g. [kitab-un] and not *[kiteb-in] ‘book’-GEN.SG., [siroz-un] and not [sirez-in] ‘cirrhosis’-GEN.SG.

Figure 3.9: Revised Turkish vowel inventory



As illustrated in (73), low vowels /ɑ, ɛ/ are within the scope of the [labial] feature as evidenced by their visible blocking of rounding harmony, but low vowels cannot undergo labial harmony – evidencing a *[labial, low] co-occurrence constraint in Turkish – resulting in neutral blocking. As in Yakut, [dorsal]-harmony is non-parasitic/unlimited. Even though /ɑ, ɛ/ cannot undergo [labial]-harmony, they are viable participants in [dorsal]-harmony, resulting in [-lər, -lar] plural suffix alternations.

(73) *[labial, low] neutral blocking in Turkish



This comparison of neutral harmony in Turkish and the previously discussed Yakut demonstrates the difference between false and true parasitic harmony systems. Conditional harmony asymmetries like those observed in the intersection of high/non-high vowels in Yakut reveal differences in the relative scope of the harmony and orthogonal features. Categorical/non-conditional harmony asymmetries like those observed in low vs. non-low Turkish vowels reveal differences in the permitted co-occurrence of harmony and orthogonal features.

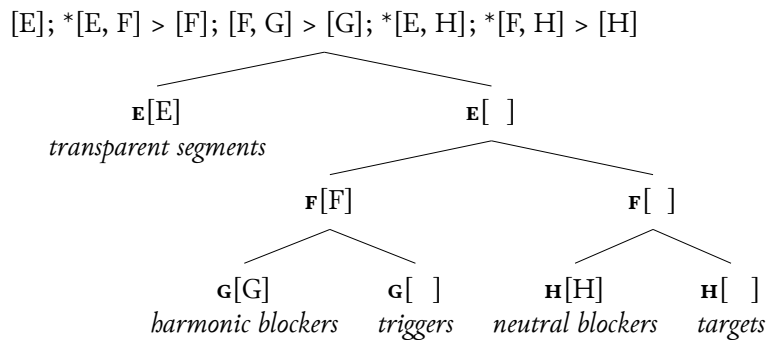
3.4 Summary

In this chapter, we have explored the basic mechanics of vowel harmony as a grammatical process. I have shown that harmony may be modeled as simple local feature spreading. In the way of a basic formalisation, I have assumed the general licensing approach outlined in (74), adapted from Iosad (2017a, pp. 52–54) and Walker (2005), which specifies 1) what segments (in what positions) must harmonise and 2) for what feature. This method captures the basic insights of Nevins’ (2010) recipient-oriented Search-and-Copy procedure or Magnetic Grammar’s feature attracting force (D’Alessandro & van Oostendorp 2018). In other words, segments which are contrastively non-specified for [F] require an [F]-specification and will copy from local [F]-specified feature-donors where available.

- (74) LICENSE(V–F, [F]):
 ‘Vowels which are contrastive for [F] should be associated with [F]’

When applied to the representational architecture outlined in chapter 2, this licensing approach captures locality variation in harmony systems via feature-scope asymmetries in the contrastive hierarchy. Variable feature scope allows for variable feature under-specification, which predicts non-/transparency asymmetries in harmony languages. In a similar fashion, variation in harmonically active/inert blocking is predicted by feature co-occurrence asymmetries in the contrastive hierarchy: i.e. obligatory [F, G] co-occurrence disallows non-F [G]-segments, resulting in [G]-specified harmonic blockers, while prohibited *[F, H] co-occurrence precludes [F, H] segments, producing [H]-specified neutral blockers. The basic harmony typology predicted by this framework is summarised in Fig. 3.10, which represents a language with [F]-harmony. This abstract schema demonstrates the specific relationship between harmony behaviour types and feature specifications, relative scope, and co-occurrence restrictions.

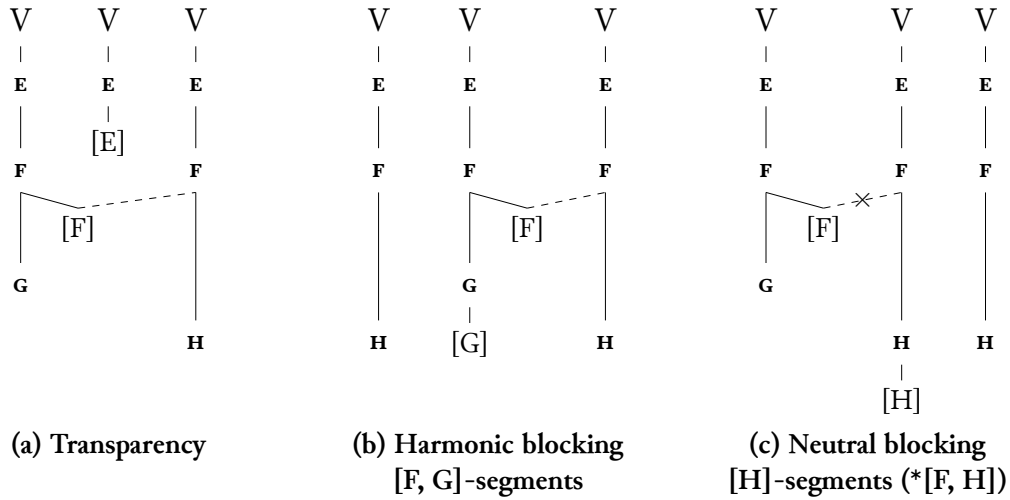
Figure 3.10: Harmony typology according to contrastive feature hierarchies



This version of Contrastive Hierarchy Theory provides an explicit harmony methodology without any need for additional grammatically specific constraints or parameters on the harmony process above those defined in the licensing principle (74). This is demonstrated in Fig. 3.11, which derivationally illustrates the five predicted harmony and neutral harmony behaviour types via [F]-spreading from [F]-specified triggers/donors to the nearest contrastively non-specified target/recipient. Note that the feature specifications

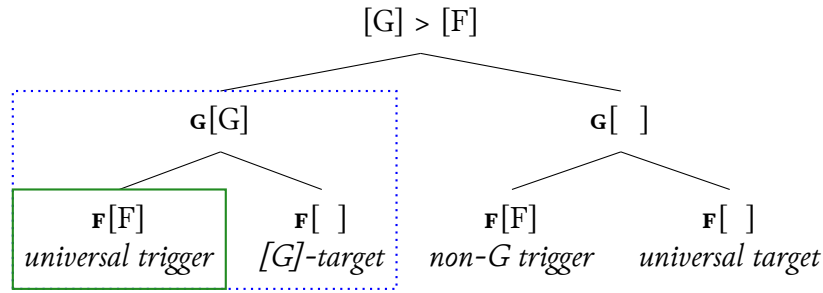
and order of feature nodes in Fig. 3.II are defined by the set of specifications and order of nodes in Fig. 3.IO.

Figure 3.II: Transparency and blocking following contrastive hierarchy representations



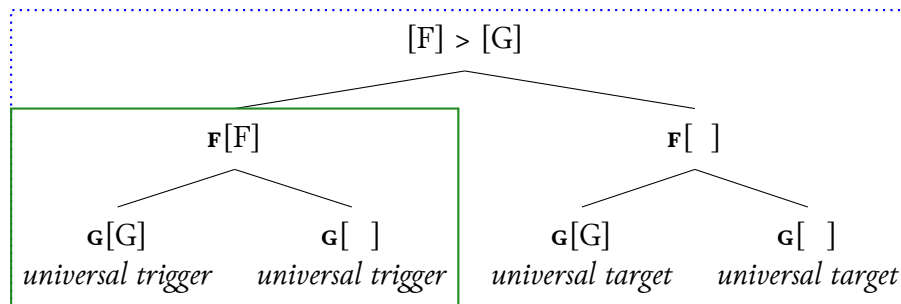
According to this framework, harmony phenomena target segments ‘within the scope of the harmony feature’. Non-contrastive, underspecified segments which lack the corresponding **F**-node are invisible to the harmony procedure (i.e. *transparent segments*), illustrated by the [E]-specified segment in Fig. 3.IIa. Vowels which are contrastive for the harmony feature (i.e. which bear the **F**-node) are broadly divided into two categories: [F]-specified *triggers* or *donors* (including harmonic blockers) and [F]-non-specified *recipients* or *targets* (including neutral blockers). Triggers and targets are further divided into alternating (harmonising) and non-alternating (blocking) segments depending on whether they are specified for some orthogonal feature which either must or must not co-occur with the harmony feature. In other words, *harmonic blockers* are simply harmony triggers which are specified for some feature [G] which must obligatorily co-occur with the harmony feature [F] (i.e. the [F, G]-specified vowel in Fig. 3.IIb). In like fashion, *neutral blockers* are simply harmony targets which are specified for some feature [H] which is prohibited from co-occurring with the harmony feature [F] (i.e. *[F, H] in Fig. 3.IIc). For a more detailed review of the typology of harmony patterns, see chapter 7.

Above and beyond the basic harmony types illustrated in Fig. 3.IO, I have demonstrated in this chapter the important role feature scope asymmetries play in deriving parasitic conditions on the harmony procedure. There is still work to be done in formalising parasitic feature ordering effects on harmony patterns, however the basic insights of this current framework provide a number of important advantages over existing approaches. First, this account makes the strong generalisation that the grammatical implementation of harmony is identical in parasitic and non-parasitic systems, universally limited by harmony-recipient subsegmental structure. Specifically, harmonisation for [F] is dependent on higher scope [G]-specifications, as illustrated by the abstract schema in Fig. 3.I2.

Figure 3.12: Conditional [F]-harmony asymmetries in a [G] > [F] contrastive hierarchy

In section 3.3, we observed that parasitic harmony systems display markedness asymmetries with respect to an orthogonal feature; for example, in Kikuyu (E.51) RTR harmony, labial vowels will only harmonise for [RTR] with other labial vowels while non-labial segments can copy [RTR] from any [RTR]-source, regardless labiality (Armstrong 1940, Peng 2000). As demonstrated in Fig. 3.12, these kinds of marked/unmarked asymmetries can be construed as hierarchical asymmetries in higher-scope feature specifications: [G]-specified targets can only assimilate to [G]-specified harmony triggers but non-G (unmarked) targets – due to their lack of higher-scope feature specifications – are ‘non-picky’. Such markedness asymmetries fall out naturally from the existing contrastive hierarchy architecture.

This approach accommodates non-/parasitic harmony asymmetries using a common grammatical mechanism for both non-/parasitic harmony languages without having to resort to stipulative, ad hoc additional rules or parameters in parasitic cases. The difference comes down to the relative scope of harmony and orthogonal features – i.e. harmony featural contrasts hierarchically depend or do not depend on some orthogonal feature [G]. The existence of non-/parasitic harmony asymmetries is therefore predicted by independently motivated feature ordering differences: i.e. parasitic [G] > [F] vs. non-parasitic [F] > [G]. The non-conditional [F]-harmony trigger/target patterns predicted by a non-parasitic [F] > [G] feature ordering are presented below in Fig. 3.13. In this case, [F]-harmony displays symmetric trigger and target classes since [F]-contrasts are not dominated by any higher-scope vocalic features. By capitalising on feature scope ordering asymmetries, this framework provides a principled, unified account of the nuanced relationship between inventory shape/contrastivity and harmony variation in both conditional and non-conditional types of harmony neutrality.

Figure 3.13: Non-conditional [F]-harmony asymmetries in a [F] > [G] contrastive hierarchy

Under this representational approach, parasitic and non-parasitic harmony systems are principally grammatically equally simple or complex, which can help explain the cross-linguistic prevalence of both types among the world's languages. In addition to the typological adequacy of this account, this contrastive hierarchy method provides explicit diagnostics for discerning and deriving true vs. false parasitic systems like Yakut and Turkish labial harmony, respectively. Namely, conditional or parasitic harmony neutrality displays marked/unmarked asymmetries with respect to some orthogonal feature in comparison to non-conditional/categorical harmony neutrality which is correlated with some orthogonal inventory asymmetry. These key differences fall out naturally from the existing contrastive hierarchy architecture and provide a strong confirmation of this approach to phonological representations.

In summary, this thesis provides a novel theory of phonological representations using the contrastive hierarchy. Building on this architecture and drawing insights from emergent/substance-free feature theories (Mielke 2008, Iosad 2017a) and Westergaard's (2009, 2013, 2014) model of micro-cues, I provide an explicit bottom-up approach to the emergence and acquisition of phonological features as well as a top-down account of how features are organised and combine to produce individual segments, phonological classes, and whole sound inventories. The principal components of this theory are applicable to any area of segmental phonology, but using the typology of vowel harmony systems as my laboratory, I have demonstrated that this framework makes concrete, testable, and accurate predictions, supplying an insightful account of the crucial role of representations in phonological patterning and vice versa.

Part III

Corpus study

Chapter 4

Old Norwegian corpus material and methods

We must...understand that they (scribes) have striven to write as they had learned to, not as they spoke. What was the general spoken language, one can thus not find using statistics.¹

Larsen (1897, p. 244) on late medieval Norwegian language and orthography

Harmony processes by nature involve a lot of moving parts – e.g. a variety of segments and feature classes of varying frequencies in different morphophonological environments, all of which may display differing harmony behaviours. Corpus studies by which these various factors may be measured numerically have proven very useful in identifying and visualising different aspects of vowel harmony systems (e.g. Mayer, Rohrdantz, et al. 2010; Sanders & Harrison 2012; Archangeli, Mielke & Pulleyblank 2012; Mayer & Rohrdantz 2013). These insights are particularly valuable in the study of historical harmony systems and their variation and change (e.g. Harrison, Dras & Kapicioglu 2006; Bobaljik 2018). Within the scope of this research, Old Norwegian provides a very valuable corpus. Over the 12th–14th centuries, Old Norwegian manuscripts, charters, and runic inscriptions preserve a great deal of geographic/chronological variation in Old Norwegian vowels and vowel height harmony. During this period, Old Norwegian lost vowel harmony and provides, to my knowledge, the only currently attested, sizeable corpus which displays all stages of vowel harmony decay. Old Norwegian is therefore a very important empirical specimen in the study of the evolution/dissolution of harmony systems (cf. Kavitskaya 2013; McCollum 2015, 2018; Bobaljik 2018). In addition to its diachronic significance, Old Norwegian displays a typologically rather remarkably complex harmony system with a number of rare and unique features – e.g. stress-dependent harmony/stress-syllable harmony blocking, a rare combination of harmonic and neutral blocking, the merger of historically harmonic and neutral vowels, as well as harmony interactions with vowel

¹‘Vi må...skönne, at man har stræbt at skrive som man havde lært, ikke som man talte. Hvad der har været almindelig talebrug, kan man altså ikke finde ved statistik.’

deletion and orthogonal assimilatory (umlaut) phenomena. A detailed corpus study of Old Norwegian vowels and vowel harmony therefore stands to provide valuable insights into the nature of vowel harmony, harmony neutrality, variation, and change.

Medieval manuscripts are however challenging material for linguistic research. Old Norwegian displays non-normalised orthography, and there is considerable variation in the representation and consistency of vowel and vowel harmony patterns. Despite this, there has been very little statistical evaluation of Old Norwegian spelling patterns (Paulsen 2015, Stausland Johnsen 2015) and little to no comparative studies of harmony systems across scribes and texts (Sandstedt 2014).

One of my principal aims in this corpus study of Old Norwegian has therefore been methodological: to develop an automated approach to the collection, annotation, and analysis of historical phonological patterns in medieval source material. This chapter outlines the sources and methods used in the collection of Old Norwegian spelling patterns and their etymological / phonological annotation. I briefly outline the reported chronological and geographic scope of height harmony in Norse dialects in section 4.1 and discuss important background to the nature and challenges of the Old Norwegian writing system in section 4.2. In section 4.3, I outline the material aspects of the elicited manuscript sources (their codicology, date, provenance, and general linguistic overview) as well as their digital sources in section 4.4. In this corpus study, I have made use of morphologically annotated and lemmatised [Medieval Nordic Text Archive](#) electronic transcriptions. Important lexical, morphological, and orthographic criteria in the data collection are specified in section 4.5. Following the example of previous corpus vowel harmony studies, I organise the data into pairwise vowel sequences. Illustrations of the basic harmony data types are outlined section 4.6. Finally, I specify the principles and techniques I have used in etymologically/phonologically annotating the orthographic data in section 4.7. Together these tools provide for a very rich database of Old Norwegian vowel letter–sound correspondences and pairwise vowel harmony correspondence. A phonologically-annotated data set of the 600 most common lexemes in this corpus is available online as a csv file at <http://dx.doi.org/10.17613/gj6n-js33>.

4.1 Chronological–geographic scope

Robust height harmony has been documented among central dialects of Old Norwegian and Old Swedish (Hødnebo 1977, Kock 1882), but the broader geographic and chronological limits of the process are not yet well understood. The earliest (possible) attestations of height harmony in Norse material come from a handful of pre-viking age runic inscriptions. Several runologists have, for example, claimed that the Eggja inscription from Sogn (KJ 101, c 650–700) features height harmonic alternations (Grønvik 1985, pp. 169–72, Krause 1971, p. 143, cf. also Olsen 1919 and Jacobsen 1931, p. 83), nearly 500 years before it is first attested on parchment. Height harmony is evidenced in forms such as **galande**, **made**, **sakse** vs. **huni**, **misurki**, **wiltir**, which display what looks like a systematic alternation of non-initial *i/e*.² These patterns, however, depend on graphic and linguistic interpretation – which vary wildly for this inscription – and there is good reason to be skeptical of generalising vowel height harmony on the basis of such few, early inscriptions.

²Runic transliterations are traditionally represented by bolded text.

Later runic material is less informative. Although the lexicalisation of various umlaut effects by the late Viking Age increased the vowel inventory of Proto-Norse from five to at least ten qualitatively distinctive monophthongs – most with both nasal and length contrasts – the number of both consonant and vowel contrasts in runic writing paradoxically decreased at the same time. In (viking age) younger futhorc runic inscriptions, the fortis–lenis contrast in obstruents is not represented. For instance, Proto-Norse /k, g/ <ǰ, ǰ> are represented non-uniquely in Early Old Norse runic inscriptions – e.g. /k, g/ <ǰ> – and only three or maximally four vowel graphs remain: e.g. **i**, **u**, **a**, and nasalised **A** (i.e. <ǰ, ǰ, ǰ, ǰ>). Since relative height is typically not distinguished in viking age inscriptions (e.g. <ǰ> **i** represents both /i, e/), runic writing from this period can provide no evidence with respect to height harmony. Given the limitations of the runic corpus – both in number, length, and graphemic inventory – the evidence for early height harmony in Proto- or Early Old Norse can only be tenuous at best.

Despite the lack of clear early evidence of vowel height harmony, broader geographic evidence suggests Norse vowel harmony was much more widespread than typically reported. While it has not received much attention, height harmony is attested outside of central Scandinavia. Scattered textual material in the British Isles, Iceland, and Greenland all provide positive evidence of height harmony or its remnants. Later in the High Middle Ages, vowel distinctions increased in runic script again by the addition of diacritics (e.g. <ǰ> /i/ vs. <ǰ> /e/). With these runic innovations, we can discern height contrasts in /i, e/ and /u, o/ in post-viking age inscriptions. For example, the 12th-century Maeshowe inscription in (75) from Mainland Orkney, Scotland, carved by the man *most rune-skilled west of the sea* features a regular alternation between high and mid vowels (e.g. **fyrir** ['fyrir], **þæiri** ['θeiri] vs. **øhse** ['økse], **ate** ['a:tte]).

(75) **Maeshowe No. 20** (Barnes 1994, pp. 144–58)

§A <þisar runar> §B rist sa maþr · er · runstr er · fyrir §C uæstan haf
 §A þessar rúnar §B reist sá maðr, er rúnstr er fyrir §C vestan haf,
 §D mæþ · þæiri øhse · er ate · kþukr · trænilsonr fyrir · sunan lant
 §D með þeiri øxe, er átte Gaukr Trandilssonr fyrir sunnan land.

‘These runes carved that man who is most rune-skilled west of the ocean with that axe which Gaukr Trandill’s son owned in the south of the country [Iceland].’

The identity of the carver is a matter of debate (cf. Barnes 1994), but given the phrase *fyrir vestan haf* ‘west of the sea’ by which the carver seems to identify himself as an islander and the use of the principally Icelandic phrase *fyrir sunnan land* ‘in the south of the country’, it has been assumed he is either Orcadian (Olsen 1903, pp. 24–25) or Icelandic (Hermann Pálsson 1962).³ Height harmony consistent with that found in Norway is also attested in Orcadian charter material; for example, the charters DN II 168/170 both sent in 1329 from Kirkwall (Norse: *Kirkjuvagr*) by Katarina, the Countess of the Orkneys and Caithness (Norse: *Orkneyjar* and *Katanes*). It has even been speculated (see Flom 1934b) that vowel height harmony was loaned from these Norse speakers into Scots, as a form of height harmony is found today in a variety of Scots spoken in Buchan (Paster 2004, Youssef 2010).

³The Gaukr Trandilssonr mentioned in the inscription was according to the Icelandic *Book of Settlements* a 10th-century farmer from Stöng in Þjórsárdalur in Southern Iceland, which has also been taken as non-linguistic evidence of Icelandic authorship.

Statistical tendencies towards height harmonic distributions in certain Icelandic manuscripts may indicate post-harmony decay remnants in Old Icelandic (Flom 1934a), and even as far west as Greenland there are indications of height harmony; such as in the first of the Garðar stones (GR 1, ca. 13th–14th century) or the Kingittorsuaq stone (GR 1, ca. 1200/1250 or later) which contrast non-high *gleðe gleðe* ‘gladness’ or the name *baanne Bjarne* versus *huilir hvílr* ‘rests’ or *fyrir fyrir* ‘before’. While it is not certain where these runecarvers came from, height harmony appears to have been a feature of at least some Greenlandic Norse speakers since the latter inscription also displays the regular occlusion of *p > t* (e.g. in the patronym *torta=r son Þórðarsonr*) which is a common feature of Greenlandic inscriptions (Hagland 1989).

All this evidence taken together suggests that vowel height harmony was likely chronologically and geographically far more pervasive than a survey of the preserved material might at first suggest. However, we still lack a detailed understanding of the patterning, variation, and decay of vowel harmony even in the well-studied corpora of Old Norwegian manuscript material, making the evaluation and interpretation of harmony evidence at the edges considerably speculative. This and the following chapters provide a detailed investigation of height harmony in a range of 13th-century Old Norwegian manuscripts which display a spectrum of robust, transitional, and decayed harmony systems. This study may serve as a baseline against which future studies of broader Old Norse vowels and vowel harmony may compare.

4.2 Philological preliminaries to historical phonology

Medieval Norway inherited roman writing from Old English and Latin, but Old Norwegian partially inherited and partially innovated certain characters to accommodate its considerably larger vowel inventory – e.g. ligatures <æ>, <œ>, <æ> for /æ, ø, ɔ/, etc. However, with at least ten distinctive monophthongs and three diphthongs, the Old Norwegian graphemic inventory in both roman and runic writing was never fully sufficient to represent all qualitative vocalic differences in writing. Additionally, while vowel and consonant length were contrastive in Old Norwegian, vowel length differences are typically not represented in writing. This is illustrated by typical orthographic representations of segment length in (76). Occasionally, long vowels are distinguished by diacritics or digraphic spellings – e.g. <aa> or <á> – but no manuscript does this consistently.

(76) Representation of segment length in Old Norwegian writing

[VC]	/fat/	<fat>	‘a piece of clothing’
[V:C]	/fa:t/	<fat>	‘fumbling’
[VC:]	/fatt/	<fatt>	‘erect’-NOM./ACC.N.
[V:C:]	/fa:tt/	<fatt>	‘few’-NOM./ACC.N.

In the study of historical vowel systems, in general, and of Old Norse, in particular, philologists use a combination of comparative and internal reconstruction, metrical evidence from poetic constraints on syllable weight / segment length, and distinctive spelling patterns to reason out the number of qualitatively and quantitatively distinctive speech sounds in the language (see Hreinn Benediktsson (2004c) for an overview and Hreinn Benediktsson (1972, 2004a) for illustrative examples of these methods in practice).

Old Norse philologists are more or less in agreement about the number of Old Norwegian contrastive vowel units, but finer details such as their featural specifications, the number of distinctive qualities and intersegmental relations are left to linguistic interpretation. As I discussed in chapter 1, a classical problem in the treatment of Old Norwegian vowels regards low *i*- and *u*-umlaut-product vowels: *æ* and *ø* in normalised Old Norse orthography. For example, despite the fact that the root-vowels in normalised *setja* ‘set’ and *séta* ‘reconcile’ are typically represented identically as <æ> in Old Norwegian writing, these words display consistently differing dis/harmony patterns: e.g. height disharmonic <sæt-ti> ‘set’-PRET.INDIC.3.SG. and height harmonic <sæt-te> ‘reconcile’-PRET.INDIC.3.SG. It is clear from metrical evidence that these vowels differ in quantity (Hreinn Benediktsson 2004a), but quantity alone typically does not result in differing harmony patterns in other Old Norwegian vowels (umlaut products or not). For example, both long and short /*ø*, *ø*:/ in the *Legendary saga of St. Olaf* (De la Gardie 8 fol. – c 1225–50) display uniformly harmonic patterns: e.g. <sœn-er> [søn-er] ‘son’-NOM.PL. vs. <bœn-er> [bø:n-er] ‘prayer’-NOM.PL. It is debated therefore what the relevant difference must be which conditions harmony in <sæt-te> ‘reconcile’ but not <sæt-ti> ‘set’; whether the vowels differ strictly in vowel length – i.e. [sæ:t-] vs. [sæt-] (e.g. Hagland 1978a,b; Rajić 1975, 1980; Myrvoll 2014) – or also vowel quality and, if so, in what way: e.g. [sæ:t-] vs. [sæt-] (Grønvik 1998) or [sæ:t-] vs. [set-] (S. Johnsen 2003, Sandstedt 2017). Previous research on this matter faces a couple of general criticisms. Philologists typically present no principled account of what counts as evidence of one representation or feature specification over another; the main locus of explanation in previous analyses is the above differing vowel harmony patterns which these representational differences should explain. Hence the reconstruction of low Old Norwegian umlaut-product vowels is often speculative and circular.

This thesis’ approach differs significantly from previous accounts in that phonological representations are inferred according to the independently motivated Correlate Contrastivist Hypothesis (CCH) defined in (32), which holds that phonological representations are defined by phonological activity, and the reference of phonological features is emergent and substance-free, informed specifically by phonological patterning. An important corollary of this hypothesis is that though the surface realisations of historical speech segments such as Old Norwegian vowels will always remain speculative, we can infer their phonological feature specifications and intersegmental relations on principled grounds based on each segment’s patterning in phonological processes such as height harmony. Rather than speculative interpretations of (potentially messy) surface orthographic patterns, my chief focus is on the behaviour of different etymological vocalic units in Old Norwegian segmental phonology. Using the contrastive hierarchy architecture outlined in chapters 2–3, this theory provides an explicit framework for inferring Old Norwegian phonological feature specifications / vowel classes and a clear description of vowels and vowel harmony patterns by etymological, phonological, and orthographic context. This philologically grounded but theoretically informed approach allows us to analyse Old Norwegian vowel harmony on par with other existing harmony systems, making it possible for the first time to put Old Norwegian vowel harmony in its appropriate typological context.

4.3 Material sources

The selection of sources for this study was fairly practical. To automate etymological / phonological annotations of orthographic transcriptions, detailed Part-of-Speech (lemmatisation) and grammatical annotations are required. The [Medieval Nordic Text Archive](#) currently includes five Norwegian manuscripts of considerable size which are both lemmatised and morphologically annotated, listed in Table 4.1. For ease of reference, I abbreviate manuscript call signatures as indicated in the left column of Table 4.1. The corpus contains in total around 279,800 words of largely saga literature from varied Eastern, Western, or unknown provenances.

Table 4.1: The selected Old Norwegian manuscript corpus

Abbr.	Signature	MS or work title	Date	Provenance	Words
AM243	AM 243 b α fol	<i>King's Mirror</i>	c 1275	Bergen	63910
DG4_7_h1	De la Gardie 4–7, fols. 17va6–29v	<i>Strengleikar</i> –hand 1	c 1270	Bergen	19813
DG4_7_h2	De la Gardie 4–7, fols. 30r–43v	<i>Strengleikar</i> –hand 2	c 1270	Bergen	18640
DG8	De la Gardie 8 fol, fols. 70v–110v	<i>Legendary saga of St. Olaf</i>	c 1225–50	Trøndsk	41142
H6	Holm perg 6 fol	<i>Saga of Barlaam and Josaphat</i>	c 1275	Eastern	76411
H17	Holm perg 17 4to	<i>Saga of Archbishop Thómas</i>	c 1300	Uncertain	59884

All dialects of Old Norwegian begin to display signs of harmony decay in the late 13th and especially throughout the 14th century. In this corpus study, I have included both manuscripts with and without vowel harmony. This is the first available corpus which documents in detail vowel harmony loss in progress, providing invaluable evidence of a vowel harmony language's pre-, transitional, and post-harmony decay stages. These results are summarised in section 5.3. In philological terms, this diachronic, comparative study provides a much more detailed picture of what both robust/phonologically active vowel harmony systems look like in medieval orthography in comparison to transitional or decayed harmony systems. In the following sections (4.3.1–4.3.5) I provide concise summaries of each manuscript's philological and codicological structure and background.

4.3.1 AM 243 b α fol.: *King's mirror*

AM 243 b α fol. (AM243) comprises 'the chief Norwegian manuscript' of the so-called *King's mirror* (*Konungs skuggsjá* or *Speculum regale* in Old Norse and Latin). This is an educational/encyclopedia text (an example of *speculum* literature, [Bradley 1954](#)) in the form of a dialogue between father and son. The *King's mirror* is preserved in ca. 60 manuscripts of different provenances and ages – all fragments. AM243 is the largest and most complete, containing approximately 80% of its original content ([Holm-Olsen 1983](#)). The codex is today housed at Arnamagnæan Institute in Copenhagen. See [Flom \(1915\)](#), [Finnur Jónsson \(1920\)](#), and [Holm-Olsen \(1983\)](#) for editions. See [Tveitane \(1971\)](#) for a useful selection of much of the most important secondary literature on the *King's Mirror* and [Stensaker \(2016\)](#) for a recent palaeographic and text-critical study of this manuscript and related fragments. An electronic diplomatic transcription with lemmatisation and morphological annotations of AM243 is available in the [Medieval Nordic Text Archive](#), encoded and edited by Språksamlingane and Juliane Tiemann.

Regarding the age of this manuscript, there is fair agreement among researchers that the manuscript was written around the last quarter of the 13th century ([Flom 1915](#); [Finnur](#)

Jónsson 1920; Hægstad 1935; Holm-Olsen 1952, 1983). Some of the more archaic features found in AM243 which provide the basis for this dating are the general observance of the so-called ‘palatal rule’ from Latin orthography in [k]-spellings (i.e. where <c> is used before back vowels and <k> before front vowels; e.g. ‘take’-INF./3.PL.PRES.SUBJ. <taca>/<take> for [taka]/[take]) and the use of <ð> for [d] following sonorants (e.g. <sœmð> for normalised *sómd* ‘honour’). These features decrease in use over the course of the 13th century, and Hægstad (1935) and Holm-Olsen (1952) suggest therefore the scribe cannot have received his or her scribal training long after 1250. At the same time, the manuscript displays some innovative features such as the use of -i for earlier -a in 1.SG. suffixes, -r for -ð in 2.PL. suffixes, and a propensity of dental -z and -zt reflexive suffixes for older velar -zk or -zc forms which first become more frequent later in the century. For a more detailed description of the language of AM243 and its chronology, see Flom (1922), Hægstad (1935), and Holm-Olsen (1952).

In contrast to the manuscript’s chronology, there has been less agreement about the manuscript’s provenance. The manuscript appears to display a mixture of prototypically Western and Eastern Norwegian features. Flom (1915) proposes therefore that AM243 was written in southeastern Norway but was copied from a southwestern exemplar. Hægstad (1935, p. 91) argued rather that the exemplar was Trøndsk and that the scribe came from ‘east in the southwestern dialectal area’ (*aust i det sudvestlandske maalvaldet*). Sørli (1950) and Holm-Olsen (1952) posit an alternative hypothesis. They argue that the scribe should be sought in the vicinity of Bergen. This idea builds in particular on inconsistency thought typical for the Bergen area in the orthography of *u*-umlaut (e.g. <oðrum, aðrum> for [ɔðrum] ‘all’-DAT.PL.) and additionally on a particular asymmetry in vowel harmony Holm-Olsen (1952) claims to observe in this manuscript.

AM243 was written around the time Old Norwegian vowel harmony begins to decay, and this manuscript only displays inconsistent remnants of vowel harmony. Nevertheless, Holm-Olsen claims that vowel harmony in AM243 is more regularly implemented with back [u, o] vowel suffixes than in front [i, e] vowels and that this asymmetry is a recognisable feature of late 13th-century Bergen charters. This claim should however be drawn into question. First, the geography and chronology of Old Norwegian vowel harmony and harmony loss is currently poorly understood. Second, as I explore further in section 5.3, this manuscript has a fully decayed vowel harmony system – with no measurable harmony effects one way or the other. And finally, related to this point, Holm-Olsen’s generalisation is incorrect; in harmonising contexts in AM243, 53.6% (2491/4649) of front vowels are height harmonic with respect to preceding vowels in comparison to 50.5% (1181/2337) of back vowel suffixes; that is, at roughly 50% there is no active harmony to speak of, no considerable asymmetry in front and back vowels, and certainly no more harmony in back vowel suffixes than front vowel suffixes. In sum, AM243 may well have been written in Bergen, but a much broader and more critical survey of Old Norwegian dialectal geography and chronology is required to say much concrete about the provenance of more ambiguous cases such as AM243.

4.3.1.1 Support and content

For outlines of manuscripts’ support and content elicited in this thesis, I follow Clemens and Graham’s (2007, pp. 129–33) manuscript description guidelines. Following Holm-Olsen (1983), the manuscript today is approximately 278 mm (height) × 215 mm (width)

and consists of 68 leaves, written in one hand, with a number of larger lacunae – originally 86 leaves in 11 quires. The collation of the manuscript in its current form is as follows: 1⁸ (wants 1–3), 11⁸ (wants 1–8), 111–114⁸, 115⁸ (wants 1), 116–119⁸, 120⁸ (wants 8), 121⁶ (wants 6–8). The AM243 manuscript contains one text, the *King's Mirror* (*Konungs skuggsjá*), whose incipit and explicit (the beginning and ending lines of a text) are provided below; italicisation marks expanded abbreviations.

1. **fols. 11–68v.** Goðan dag hærri minn. Ec em spa ko-minn til yðars...æinn at mæð goðri skynsæmð oc langri ahyggiu hæfði firi ser bruat hværiu hann æigi at spara.
King's Mirror

4.3.2 De la Gardie no. 4–7: *Strengleikar*

De la Gardie 4–7 is a composite manuscript of what were originally two manuscripts. The age and provenance of these manuscripts are fairly non-controversial, both thought to be written in the second half of the 13th century in the southwestern or Bergen area of Norway (cf. Hægstad 1935, p. 23; Tveitane 1972; Cook & Tveitane 1979). The remains of the first manuscript today only consist of a pair of leaves which contain the end of the *Saga of Óláfr Tryggvasonr*. The second manuscript includes *Pamphilus saga*, 13 lines of a dialogue between courage and fear, the *Saga of Elís and Rósamunda*, and finally a collection of prose texts based on the Old French *Lais* of Marie de France known as *Strengleikar* ('stringed instruments', the Norse equivalent to *lais*).

The codex is today housed at Uppsala University Library. For a facsimile edition, see Tveitane (1972). Electronic transcriptions of *Pamphilus saga*, the *Saga of Elís and Rósamunda*, and *Strengleikar* are available in the [Medieval Nordic Text Archive](#). *Pamphilus saga* is encoded by the so-called [Bergen group \(1\)](#) at the diplomatic level with digital facsimiles provided. The *Saga of Elís and Rósamunda* is transcribed at the diplomatic level by Ingvil Brügger Budal. And finally, *Strengleikar* is encoded at the diplomatic level with lemmatisation and morphological annotations by the Gammelnorsk Ordboksverk. For this thesis's database, I have made use of this last transcription (fols. 17va6–43v according to current foliation). This manuscript fragment is written in two hands, which I abbreviate DG4_7_h1 (fols. 17va6–29v) and DG4_7_h2 (fols. 30r–43v), respectively.

4.3.2.1 Support and content

De la Gardie 4–7 today consists of 44 leaves in 8 quires. Remains of the 8th quire were found by Árni Magnússon in 1703 as the lining of a bishop's mitre in Skálholt in Iceland and are catalogued separately as AM 666b 4to in Copenhagen. The parchment measures approximately 310 (height) × 230 (width) mm. Following Tveitane's (1972) description, the collation of De la Gardie 4–7 in its current form is: 1² (wants some unknown number of leaves), 2⁵ (wants 4–6), 3⁶ (wants 3 and 6), 4–5⁸, 6⁶ (wants middle pair),⁴ 7⁷ (wants 4), 8² (wants 2–7; some of which are found in AM 666b 4to).

During binding, the middle pairs of leaves in the 5th quire (according to the current collation) were incorrectly reversed, such that they now are in the wrong order (from $\frac{4-5}{3-6}$

⁴Tveitane (1972, p. 9–10) here does not specify what he means by the 'middle pair', either 3 and 6 or 2 and 5.

to $\frac{3-6}{4-5}$). A photograph of the unfortunate remnants of the 8th quire are reproduced in figure 4.1 (Haugen 2015).

Incipits and explicits are provided below to aid in textual identification. As listed below, the first manuscript – containing fragments of *Saga of Óláfr Tryggvasonr* – comprises fols. 1r–2r, written in one hand (Hand A). The second manuscript is written in three hands, the first (Hand B) is responsible for fols. 3r–17va5, containing *Pamphilus saga*, the dialogue between courage and fear, and the *Saga of Elís and Rósamunda*. Finally, *Strengleikar* is written by the remaining two hands, which were responsible for about equal portions of the texts. The first hand (Hand C or DG4_7_h1 in the thesis’ database) comprises fols. 17va6–29v with the second hand (Hand D or DG4_7_h2) taking over at fols. 30r–43v. For a comparison of each hand’s palaeography and orthography, see Tveitane (1972) and citations therein.

Figure 4.1: The fragment of *Strengleikar* AM 666b 4to now in Copenhagen was cut to be used as the lining of a bishop’s mitre



1. **fols. 1r–2r.** .En. *Olafs konongs menn flyðu þa allir upp a orminn langa af oðrum...ki. þo at æigi se sagan saman sett með mikilli malsnilld.*
Fragment of *Saga of Óláfr Tryggvasonr* — Hand A
2. **fols. 3r–5v.** EC EM SÆRÐR. *oc ber ec gaf lak undir hiarta mínu. sár...Sua at saumu. fœðer þu mik með flærðsamligum. hugganum. at ryggglæikr oc harmr. brottfaRi*
Pamphilus saga (a translation of the Medieval Latin dialogue *Pamphilus de amor*) — Hand B
3. **fol. 6ra1–14.** sem þui hava á visat. en aðrir limir fylgð væita. *Æðra mæliR.* Gagnmæli lyt ec nu sem fyrr. *oc androða...kiosa ser rett efni. oc siðan vera fast halldr a þui.oc þui fylgia oc iamnan gott gera.*
Dialogue between ‘courage and fear’ (*hugrecki ok æðra*) — Hand B
4. **fols. 6ra14–17va5.** [H]ÆY’RIT horskir menn. *æína fagra saugu. dyrlegs drengscaps. um raustan ridde...þessa hæims gratiam. en í sinu riki sanctorum gloriam. AMEN.*
Saga of Elís and Rósamunda (a translation of the Old French *chanson de geste* *Elie de Saint-Gille*) — Hand B
5. **fols. 17va6–43v.** AT hæve þæirra er i fyrnskunni varo likaðe oss at forvitna oc rannzaka þui at...oc leiddi hann þa i svefnloft sitt. *oc sa hann þar gæzlo menn hennar sofande. þa synde hon honum oc mællti*
Strengleikar — Hand C & D [DG4_7_h1 & DG4_7_h2]

4.3.3 De la Gardie no. 8 fol: *Legendary saga of St. Olaf*

De la Gardie no. 8 fol. is a codex of two originally distinct Norwegian parchment manuscripts containing copies of *Magnus the Law-mender's national lawcode* (*Magnúss lagabótis landslog*) and the *Legendary Saga of St. Olaf* (*Ólafs saga hins helga*), written in the 14th and 13th centuries, respectively. The manuscripts were originally separate, being joined together around the end of the 16th century. The codex is today housed at the Uppsala University Library. See Keyser & Unger (1849), O. A. Johnsen (1922), and Holtsmark (1956) for editions. Digital facsimiles are available from Uppsala University: <http://www.alvin-portal.org/alvin/>. Electronic transcriptions of both manuscripts are available in the [Medieval Nordic Text Archive](#): *Magnus the Law-mender's national lawcode* encoded by Anna C. Horn at facsimile and diplomatic levels and *Legendary Saga of St. Olaf* encoded at the diplomatic level with lemmatisation and morphological annotations by the Gammelnorsk Ordboksverk.

For this study, I have made use of the latter transcription – the *Legendary Saga of St. Olaf* – which I abbreviate as DG8. This is one of the largest preserved Norwegian manuscripts from the earliest period. It has been dated to c 1250 and is generally thought to be written in Trondheim (Hægstad 1899, 1922; Seip 1955, p. 91). More precise palaeographic and codicological descriptions can be found in Storm (1885, pp. 702–05). For more detailed orthographic descriptions of the *Legendary Saga of St. Olaf*, see Hægstad (1899) and especially Hægstad's (1922, pp. xxviii–lvii) introduction to Johnsen's (1922) edition.

4.3.3.1 Support and content

De la Gardie 8 fol. consists altogether of 98 parchment leaves with 15 added leaves of paper in the following configuration: ii + 57 + xii + 41 + i. That is, 2 (originally 4) paper leaves at the foremost and 1 leaf at the backmost cover along with 12 leaves between fols. 57–69 (the initial paper leaves have not been included in the foliation). The parchment measured maximally from margin to margin is approximately 263 (height) × 194 mm (width) in its current dimensions. The collation of the manuscripts in their current form is as follows (parchment quires represented in bold): i², **ii–iii**⁸ (wants 1–2), **iv**⁷, **v–viii**⁸ (wants 2, 3, and 6), **ix**¹⁰, **x**⁸ (wants 3), **xi**², **xii**⁴ (wants 1), **xiii–xvii**⁸ + 1 after 5, Singleton (paper).

During rebinding the codex was trimmed, affecting the upper lines and marginal notes in a few places (e.g. top of fol. 91). About one-third of one parchment leaf (fol. 34) has been cut away but without affecting any text. The first folio of the *Legendary saga* is considerably soiled, indicating that it served as the manuscript's cover prior to binding.

Incipits and explicits for each text are provided below. As outlined there, the first manuscript – *Magnus the Law-mender's national lawcode* – comprises fols. 1r–57v, written in three different 14th-century hands. The second manuscript – the *Legendary Saga of St. Olaf* – from the second quarter of the 13th century spans fols. 70v–109v (or 1v–41v when counted on its own) and is written in one hand. In addition to the law-code and saga texts, smaller works have been added in various places at later times as indicated below.

1. **fols. 1r–52v20.** ‘dominus nobiscum’ mAgñuf með guðz mífkun konongr fon...þa flkalu þær flikra uittna níota ok undan þezlo fem konongf ermífkun til.
Magnus the Law-mender's national lawcode (Frostathing Law) — c 1300–50

2. **fols. 52v20–53v28.** **vm rettar bōtr kononga** þEflar rettarbōtr gaṛ hakon konongr fōnr hakona2 konongs allum ṛro...ga olafṛ konongs fē med off nu ok iamnan lete gud off hæila skilliazt ok fua ṛinnazt
rétterbótr (ammendments to existing law) of Kings Hákon and Magnus and Magnus's epilogue (til Frostathing 1274) — c 1300–50
3. **fols. 53v28–57v.** **her hæpir upp ṛarmanna log** Sv er logleg ṛarteckia en ængi annur at i hond skál taka stýrimanne...eṛ liggia þar við fēm býgkt er En eṛ eigi er lyft þa ma fá þíof fōk a geṛa.
Farmanna Law (Farmannalög) — c 1300–50
4. **fols. 58r–59r.** En eṛ made2 dzege2 vp ackeṛ...al2a 2eṛfinga æṛti2 mott māna dome
Apparent continuation of *Farmanna Law*, cursive hand — c 1500–50
5. **fols. 59v–69v.** Blank.
6. **fol. 70r1–9.** Eiliṛ liṛanda gvð...beðe vaganðe oc foṛanðe vtan eenda
Prayer, *a mala* or *maligna morte*, hand a?
7. **fol. 70r10–18.** ek vill nv ṛírír guði klagā...ṛra mínv hiarta no venða fiolf \er/m hon mei stare vtan enða
Prayer, hand b?
8. **fol. 70r19–32.** Eṛ iola dag bær a drottens d...husbruni værdhr uida...
Uncertain content, largely illegible, two to three cursive hands — c 1400s
9. **fols. 70v–109v.** Son Harallz hins harfagra var biorn kaupmaðr, faðer guð ...utan ænda ivir verolld verallda. A M E N.
Legendary Saga of St. Olaf — c 1225–50

4.3.4 Holm perg 6 fol: *Barlaams ok Josaphats saga*

Holm perg 6 fol. (H6) is a mid-to-late 13th-century manuscript containing the *Saga of Barlaam and Josaphat*, a religious tale based upon legends of the life of Buddha. For editions and critical overview, see [Keyser & Unger \(1851\)](#) and [Rindal \(1980, 1981, 1987\)](#). The manuscript is housed at the National Library of Sweden in Stockholm, and an electronic transcription with lemmatisation and morphological encodings prepared by Magnus Rindal is available in the [Medieval Nordic Text Archive](#).

Both the date and provenance of the manuscript's writing are somewhat debated. A concrete *terminus post quem* is provided by the *Saga of Guðmundr Arason* which reports that the manuscript's text – the *Saga of Barlaam and Josaphat* – was translated by 'Hákon konungr ungi' or 'King Hákon the Young', now widely accepted as referring to King Hákon Hákonarson (1232–57) ([Maurer 1867](#), [Storm 1886](#); see [Haugen & Johansson 2009](#) for textual overview). H6 is not original but a copied manuscript ([Rindal 1987](#)) and cannot therefore be older than about 1250. Like AM243 discussed in section 4.3.1, H6 displays a number of younger features such as the use of *-i* for earlier *-a* in 1.SG. suffixes, *-r* for *-ð* in 2.PL. suffixes, *-z* and *-zt* reflexive suffixes for older velar *-zk* or *-zc* forms, and the palatal rule is not followed. But at the same time H6 retains a robust vowel harmony system, and [Rindal \(1987, pp. 138–39\)](#) argues on the basis of these combined features that H6 cannot

be younger than AM243 – dating the manuscript to c 1275.⁵ Regarding the provenance of the manuscript, it is generally accepted that it was written somewhere in Eastern Norway on the basis of orthographic features such as the presence of vowel harmony, prevalence of perseveratory *j*-umlaut (<ia> for **ja*), and orthographically unmarked *u*-umlaut ([ʊðrum]–<aðrum>, *<oðrum>) (Rindal 1981; Tveitane 1973, p. 49; Seip 1955, p. 92).

4.3.4.1 Support and content

The manuscript in its current form measures ca. 220 mm (height) × 155 mm (width), written in two columns by one writer. The manuscript consists of 102 leaves with 5 added paper leaves. According to Rindal (1981), the manuscript likely consisted originally of 15 quires with 4 leaves (2 bifolia) each. Of these, the first quire is now missing. The current collocation is: ii + i⁸ (wants 1 & 8), ii–v⁸, vi⁸ (wants 2), vii–ix⁸, x⁸ (wants 4), xi⁸, xii⁸ (wants 1 & 6), xiii⁸, xiv⁸ (wants 1–2, 7–8) + iii. The manuscript consists of one text, the *Saga of Barlaam and Josaphat* (*Barlaams ok Josaphats saga*), whose incipit and explicit are provided below.

- i. **fols. 1r–102v.** mællte ekki fleirum orðom við hann at sinni. en firir þui at honom...hin agiæta tign. oc dyrð. með feðr oc helgum annda. firir vttan ennda.
Saga of Barlaam and Josaphat

4.3.5 Holm perg 17 4to: *Saga of Archbishop Thomas*

Holm perg 17 4to (H17), housed at National Library of Sweden in Stockholm, contains the most extant copy of the *Saga of Archbishop Thomas* (*Thómas saga Erkbiskups*), relating the life of Saint Thomas Becket of Canterbury (c 1119 – 1170), likely based on a translation of the so-called *Quadrilogus prior* written soon after Thomas' canonisation (1173). See Unger (1869) and Eiríkr Magnússon (1883) for editions. A lemmatised and morphologically annotated, electronic transcription at the diplomatic level is available in the [Medieval Nordic Text Archive](#). H17 is dated to c 1280 by Hægstad (1905, p. 10) and Seip (1955, p. 92). Unger (1869), Kålund (1905, Nr. 43), and Jakobsen (1977b,a) assume a slightly later date, c 1300 on the basis of a number of innovative features in the manuscript, such as *-z* and *-zt* reflexive endings and frequent analogical 3.SG.PRES.INDIC./SUBJ. *-r* and *-i* endings in the 1st person: e.g. *oc af þi seger ec* 'and for this reason I say', instead of historical *segi*-1.SG.PRES.

The provenance of this manuscript is very unclear. It features a variety of peculiar Icelandicisms. Some examples following Jakobsen (1977b) are Icelandic voiceless *r* spellings as in *bryggiligr* with Icelandic *br* but which alliterates with (voiced) *r* in *bryggelega ræðu* 'mournful speech', indicating a Norwegian (voiced) pronunciation: i.e. *ryggelega ræðu*. A couple of times long [e:] is spelled digraphically as <ie> – corresponding to the diphthongised Icelandic pronunciation [je] as opposed to Old Norwegian [e:], and like Old Icelandic the manuscript lacks vowel harmony. There are a good number of 14th-century marginal notes in Icelandic in the manuscript, which illustrate the manuscript

⁵This estimated dating is largely consistent with earlier estimates: e.g. the middle of the 13th century by Keyser & Unger (1851), Gödel (1897, p. 19), and Kålund (1905, no. 21); around 1270–80 by Knudsen (1936, p. 181); and 1260–70 by Seip (1955, p. 92).

must at least have been in Iceland early on (cf. Unger 1869, p. viii), and all other Norse accounts of the *Saga of Archbishop Thomas* are Icelandic. For this reason, there has been some confusion about the language of the manuscript; in his edition, Eiríkr Magnússon (1883, p. lx) claims that is ‘clearly of Icelandic workmanship’, which is now unanimously rejected (cf. e.g. Stefán Karlsson 1973, Jakobsen 1977b). There are namely quite a number of conclusively Norwegian features in H17 – for example, the lack of orthographic *u*-umlaut (e.g. [‘ððrum] <ððrum> rather than Icelandic <öðrum>/<øðrum>), the commonly voiced *l*, *n*, *r* rather than Icelandic *hl*, *hn*, *hr*, Norwegian pronominal forms such as *mek*, *þessor*, and so on; see Jakobsen (1977b) for a more complete discussion. Moreover, other Icelandic sources attribute the *Saga of Archbishop Thomas* to Bergr Gunnsteinsson and Jón Holt, the latter of which may have been a Norwegian judging from his last name *Holt*, meaning ‘a wood’. The use of toponyms as last names was atypical in Iceland but much more common in Norway, and Stefán Karlsson (1973) suggests it is likely the text was written in Iceland by a Norwegian. This could explain the odd mixture of Icelandicisms/Norwegianisms in this text.

4.3.5.1 Support and content

Following Unger (1869), the codex today consists of 92 leaves, divided between 14 quires – of which each likely originally contained 8 leaves. Given lacunae in the text, Unger (1869) assumes two quires are missing between the current sixth and seventh quire. The following collation assumes originally 16 quires: 1⁸ (wants 1–2 and 8), 11⁸, 111⁸ (wants 2), 1111⁸, 11111⁸ (wants 4–5), 111111⁸ (wants 1–8), 1111111⁸ (wants 1–8), 11111111⁸ (wants 3–6), 111111111⁸ (wants 4–5), 1111111111⁸ (wants 5), 11111111111⁸ (wants 6), 111111111111⁸ (wants 6), 1111111111111⁸ (wants 1–2, 5–7; 4 is clipped and a strip is torn away from 8). The manuscript contains one text, *Saga of Archbishop Thomas* (*Thómass saga erkbiskups*), whose incipit and explicit are included below.

1. **fols. 1r–92v.** Hæilagr thomas var foeddr ok upp fostraðr j lunduna borgh a ænglande...meðr þæima hætte til guðs. En þu mun ok marka væl mina sogn oc tima. En litlum tima liðnum man þetta prouaz. meðr manna sannre sogn.
Saga of Archbishop Thomas

4.4 Medieval Nordic Text Archive transcriptions

Historically, the analysis of Old Norwegian vowels and vowel harmony has been nearly exclusively qualitative and fairly uni-dimensional insofar as phonological, orthographic, and/or etymological factors influencing harmony patterns are not known or distinguished in Old Norwegian vowel harmony studies. Medieval Nordic Text Archive (MENOTA) digital transcriptions provide Old Norwegian texts in a form suitable for large-scale corpus linguistic research. Using these lemmatised and morphologically annotated transcriptions, the collection and mark-up of vowel sequences from medieval manuscripts can be largely automated. The goal of this current study is to provide a quantitative study of phonological and orthographic factors influencing harmony patterns and their interaction with orthogonal sound processes (e.g. umlauts, vowel deletions, etc.) and ongoing sound changes (e.g. vowel mergers/shifts).

MENOTA transcriptions are encoded in XML. See Haugen (2008) for encoding guidelines. An example of a MENOTA transcription of one word and the kind of information MENOTA transcriptions include is given in (77).

- (77) **MENOTA transcription of <iamvirðuleg> ‘equally worthy’-NOM.M.SG. (DG8 fol. 21v18)**

```
<w xml:id='w020244' lemma='iafnvirðuligr' me:msa='xAJ rP gM nS cN sI'>
<me:dip1>iamvirðuleg<ex>r</ex></me:dip1>
</w>
```

In MENOTA transcriptions, each lexical item in the corpus is delineated by a word environment (<w>–</w>), numbered with a unique ID (e.g. ‘w020244’), and linked to a corresponding lemma or normalised dictionary form (e.g. ‘iafnvirðuligr’). The majority of the corpus is morphologically annotated (e.g. ‘xAJ rP gM nS cN sI’ = ‘adjective, positive, masculine, singular, nominative, indefinite’). Finally, a transcription of the word form is provided (e.g. ‘iamvirðuleg<ex>r</ex>’). In these transcriptions, linguistically irrelevant allographic variation is levelled (e.g. insular <p> vs. latin <v>; long <f> vs. round <s>; etc.) and abbreviations are expanded—indicated by the <ex>–</ex> element (e.g. <g> → ‘g<ex>r</ex>’).

4.5 Data collection principles

Using an automated algorithm developed in collaboration with Pavel Iosad, all relevant transcriptions, linguistic annotations, and vowel sequences are collected from each word-element (77). In order to ensure the quality of data, elicited forms need to meet certain criteria. The only lexical requirement I have set is in avoiding proper nouns. Proper nouns are textually very frequent and often idiosyncratically abbreviated (e.g. <O.> for <Olaf> ‘Ólaf’-DAT.). This has the potential of significantly skewing vowel frequencies since unstressed syllables are disproportionately elided in proper nouns. In terms of morphological criteria, I have collected all words which display native Norse inflections. Non-Norse loanwords which have adopted Norse suffixes do not display any significant difference in harmony patterns from native vocabulary: e.g. [+high] (French) [kurteis-um] <kurtæisum> ‘courteous’-DAT.PL. vs. [–high] (Old English) [postol-om] <poftolom> ‘apostle’-DAT.PL. Non-Norwegian (typically Latin) material has been completely excluded.

Old Norwegian inherited Latin’s system of abbreviations which are used extensively in Old Norwegian writing. I have included only non-abbreviated vowels, but I have worked to save as much data as possible. For example, from a form such as <k̄kunar> for <kirkunar> [kirkj-u-nnar] ‘church’-GEN.SG.-DEF., (represented in MENOTA transcriptions as <k<ex>ir</ex>k<ex>i</ex>unar>) the algorithm collects the non-abbreviated vowel pair <u>–<a> but not <i>–<u>. In contrast, intervening abbreviated consonants play no role. The algorithm picks up vowel sequences in forms with and without abbreviated consonants, such as <mannum> vs. <mañū> (for <mannum>) [mɔnn-um] ‘man’-DAT.PL. from which both <a>–<u> vowel sequences are collected.

In Old Norwegian orthography, not all vowel letters are treated equally. First, as in Latin or Old English orthography, semi-vowels /j/ and /w/ or /v/ are often represented

by proto-typically vowel graphs <i>/<u>, as in <duelia> for [dvelja] ‘dwell’, but these segments have no relevance to Old Norwegian vowel harmony patterns. Additionally, Old Norwegian displays intervocalic voicing of fricatives: e.g. /f/→[v]/V__V whose orthographic equivalent is often <f>→<u>/V__V; resulting in yet additional ‘consonantal’ vowel letters. For this reason, we sometimes end up with an exceptional number of vowel graphs, such as <giauum> for [gjoʋum] ‘gift’-DAT.PL. (cf. NOM.SG. <giof> [gjoʋf]). But in such cases, for the study of vowel harmony, we are interested only in the vowel pairs <e...a> / <a...u> in <duelia> / <giauum> and not <u...e>, <e...i>, or <i...a>, etc. These confounding factors are lexically and morphophonologically predictable and are cleaned up on a lexeme by lexeme basis using mutate functions in R.

(78) **Example clean-up of graphic patterns in *giof* ‘gift’**

```
1 vh_df <- vh_df %>%
2   mutate(v1 = replace (v1, which (lemma == "giof"
3                               & str_detect(dipl, "auu")), "a" )) %>%
4   mutate(v2 = replace (v2, which (lemma == "giof"
5                               & str_detect(dipl, "auu")), "u" ))
```

The (slightly simplified) example code in (78) takes the existing database (vh_df for *vowel harmony dataframe*) and replaces existing letter entries in $V_1...V_2$ vowel sequences for the word *giof* where the transcribed form (dipl for *diplomatic transcription*) displays the sequence <auu> (that is, a clear example of intervocalic /f/-voicing represented as <u>). Words that meet these conditions are re-encoded with the correct <a...u> sequence (i.e. v_1 = ‘a’; v_2 = ‘u’). I use the same techniques to supply etymological and phonological annotations, as described in the following section 4.7.

4.6 Vowel harmony in corpus data

Vowel harmony is often characterised as the categorical correspondence for some phonological feature and modelled by across-the-board autosegmental spreading or by some other categorical mechanism (van der Hulst & van de Weijer 1995, Nevins 2010, Rose & Walker 2011). Harmony exceptions are analogously predicted to be categorical. The vast majority of harmony data are consistent with these predictions. Nearly every harmony language displays some categorical disharmony via, for example, neutral (skipping / blocking) segments, blocking by privileged positions (e.g. stress-dependent harmony; Majors 1998), or locality limitations (e.g. the apparent two syllable requirement on harmony triggers in Oroqen (Tungusic); Drescher & Nevins 2017). In all these cases, these exceptions are systematic and generalisable in discrete terms – whatever segment in whatever domain either harmonises, or it does not.

This view is however somewhat idealistic as typically every harmony languages also display some non-systematic variation which cannot be uniformly captured by categorical representations or constraints. Illustrative examples are found in variable harmony following disharmonic roots in Hungarian (Vago 1975) or unpredictable / lexically specific non-harmonising roots in Yoruba (Archangeli & Pulleyblank 1989, Ola Orié 2003). In addition to genuine linguistic variation, spelling inconsistencies in non-normalised medieval orthography like that found in Old Norwegian add yet another dimension of

potential variation. For these reasons, I employ a low-domain harmony measure in the corpus study of Old Norwegian vowel harmony, using pairwise height correspondence in adjacent syllables (cf. Harrison, Dras & Kapicioglu 2006; Mayer, Rohrdantz, et al. 2010; Archangeli, Mielke & Pulleyblank 2012; Mayer & Rohrdantz 2013).

Table 4.2: Division into pairwise harmonic spans

Harmonic span	V ₁	V ₂	V _{1_high}	V _{2_high}	VH
{hofðing} ₁ ianom	<o>	<i>	False	True	False
hof {ðingia} ₂ nom	<i>	<a>	True	False	False
hofðing {ianom} ₃	<a>	<o>	False	False	True

As illustrated in Table 4.2, for each word, the number of vowel pairs is always one less than the number of syllables. So a quadsyllabic word like [hofðingj-a-nom] ‘chieftain’-DAT.SG.-DEF. provides three vowel pairs. Height harmonic agreement (VH) is determined independently for every individual sequence given the correspondence of $V_1 \dots V_2$ relative height (i.e. $V_{1_high} = V_{2_high}$). Again, as detailed above, ‘consonantal’ vowel spellings are avoided in the database: i.e. <i> for [j] in the <hofðingianom> example. The harmony measurements I employ are thus reasonably phonologically informed and not strictly a measure of orthographic harmony.

4.7 Etymological / phonological annotations

A database of Old Norwegian vowel and vowel harmony spelling patterns such as in Table 4.2 is an initially useful tool, but it is limited what vowel orthographic patterns can reveal about Old Norwegian vowels and vowel harmony. It is considerably debated how reliably Old Norwegian spelling patterns relate to Old Norwegian sound patterns. For instance, various researchers have argued that Old Norwegian vowel harmony is partially contingent on vowel length (Hagland 1978a,b; Rajić 1975, 1980; Myrvoll 2014), but vowel length is not regularly represented in writing. It has also been argued that not all scribes represent all synchronically relevant vowel contrasts in writing, and that orthographically identical vowels have differing harmony behaviours in certain manuscripts (Hægstad 1907, p. 31; Rindal 1987; Grønvik 1998). When confronted with manuscripts which display inconsistent harmony patterns, some rule out orthographic inconsistency simply as copying interference, non-indicative of phonological harmony (Tveitane 1972), while others interpret the same patterns as genuine harmony, only with variation within the bounds which is to be expected of medieval non-normalised orthography (cf. Hødnebo 1984). Yet other studies conclude that a vowel’s function in Old Norwegian vowel harmony is not entirely synchronically predictable but influenced by the segment’s etymology (Hagland 1978a) or even that the Old Norwegian vowel harmony system is not synchronically active at all but simply represents etymological ‘relics of an older vowel system’ (‘relikt av eit eldre vokalsystem’; Kristoffersen & Torp 2016, p. 130). In sum, though textual sources have the benefit that they allow for the unambiguous collection, measurement, and comparison of orthographic patterns, their phonological interpretation is in serious question.

My approach is different from previous studies in that I augment orthographic patterns with additional etymological and phonological annotations. Using this comparative

grapho-phonological approach, we can tease apart potentially competing linguistic, etymological, and orthographic influences on surface spelling patterns. To provide a consistent reference point for each word's etymological / phonetic interpretation, I follow the representations in Holthausen's (1948) comparative and etymological Old West Norse dictionary. Holthausen's reconstructions approximate circa mid 13th-century West Norse varieties, consisting of ten qualitatively distinctive monophthongs and three falling diphthongs {au, èi, èy}.⁶ Holthausen's vowel inventory is represented in (79), but it should be noted that he makes no explicit claims about intersegmental relations such as rounding, height, tenseness, and so on. The vowels spatial groupings here are only for illustrative purposes. In section 5.1 I explore the accuracy of Holthausen's representations for this thesis' corpus data.

(79) Old Norwegian vowel representations following Holthausen (1948)

i	y	u	ī	ȳ	ū
e	ø	o	ē	ō	ō
è	a	ø	æ	ā	
(a) Short vowels			(b) Long vowels		

The characters {è, ø} in Holthausen's notation represent historically fronted and rounded short **a* (so-called *i*- and *u*-umlauted *a* in Norse philological circles). For clarity's sake, in the corpus data I use equivalent IPA representations in (80). Diphthongs are correspondingly represented as {au, ei, ey}.

(80) IPA Old Norwegian etymological vowel representations

i	y	u	i:	y:	u:
e	ø	o	e:	ø:	o:
ɛ	a	ɔ	æ:	a:	
(a) Short vowels			(b) Long vowels		

The set of vowels in Holthausen's dictionary differ from the traditional reconstructions in Table 1.1 in that he interprets long and short *i*-umlauted **a* (i.e. *è* and *æ*) as synchronically both quantitatively and qualitatively distinctive. I confirm this distinction by detailed grapho-phonological analyses of these vowels in sections 5.1, 5.6, and 6.4.

Historically, /a:/ had a corresponding rounded /ɔ:/ counterpart (i.e. long *u*-umlauted and non-umlauted **ā*). Around the turn of the 13th century, /a:, ɔ:/ merged: e.g. [ma:l] 'matter' NOM.SG./PL. < **ma:l*-SG. vs. **mɔ:l*-PL. This historical contrast is not represented in Holthausen's dictionary nor in the manuscripts included in my study. Whether the initial product of that merger was round or not has been debated (cf. Halvorsen 1984) and difficult to detect since there was generally no orthographic distinction between [a:] and

⁶Holthausen treats {ja, jo, jø} in *hjalpa*, *mjolk*, *jørð* 'help, milk, earth' as rising diphthongs contrasting with {a, o, ø} in *dagr*, *orð*, *søk* 'day, word, sake'. In my corpus, these words are recorded alike as a monophthong and/or sequence of glide and monophthong, but this difference has no consequence for the study of Old Norwegian vowel harmony patterns.

[v:] vowels in Old Norwegian writing. In modern Nordic languages, etymological *a: is rounded, but the post-merger vowel is generally represented as <a> in roman writing – the same as the non-round short vowel [a] – and rounding is not indicated in 13th-century runic inscriptions either (Spurkland 1991, pp. 161–65, 276). It has more recently been assumed that the initial product of the merger was non-round with a:-rounding being more conservatively dated to c 1300 (cf. Berg et al. 2018, p. 172). Accordingly I represent the product of the /a:, v:/ merger as [a:] in the data in this thesis – all of which come from manuscripts dating to c 1225–1300 which therefore post-date the /a:, v:/ merger but which likely pre-date rounding according to this chronology.

In exceptional cases, I depart from Holthausen’s representations. For example, as illustrated in Table 4.3, I preserve well-established dialectal variation in vowel representations in the corpus database, such as differences in the negating prefix /u:-/ vs. /o:-/ or varying plural allomorphy in the auxiliary verb *skulu* ‘shall’ and the noun *sunr* ‘son’ (cf. Noreen 1923, pp. 351–52 and citations therein). All of these examples affect word-initial vowel frequencies and the last example has obvious additional effects on harmony patterns: i.e. [+high] [syn-ir] vs. [–high] [søn-er]. Lastly, certain variation in on-going sound processes are recorded in the corpus, such as palatalisation (so-called *j*-umlaut) – for example /gjaf-a/ → [gjæva] – which is inconsistently represented in writing.

Table 4.3: Examples of variation in etymological/phonological annotations

<i>Negative prefix /u:-/ or /o:-/</i>			
<uvinr>	[u:-vin-r]	‘un-friend’; ‘foe’-NOM.SG.	DG8
<ovinr>	[o:-vin-r]	‘un-friend’; ‘foe’-NOM.SG.	H6
<i>Varying verbal allomorphy: [skɔl-] or [skul-]</i>			
<skulum>	[skul-um]	‘shall’-I.PL.PRES.INDIC.	DG8
<skalum>	[skɔl-um]	‘shall’-I.PL.PRES.INDIC.	H6
<i>Varying nominal allomorphy: [syn-] or [søn-]</i>			
<søener>	[søn-er]	‘son’-NOM.PL.	DG8
<synir>	[syn-ir]	‘son’-NOM.PL.	H6
<i>j-umlaut: [ja] or [jæ]</i>			
<giava>	[gjav-a]	‘gift’-GEN.PL.	H6
<giæva>	[gjæv-a]	‘gift’-GEN.PL.	H6

Furthermore, obvious inconsistencies in Holthausen’s (1948) entries are corrected, such as his varying representation of the nominalising derivational suffix *-endi* as both *-endi* and *-ëndi*. Iversen (1955, p. 211) reconstructs this suffix as the *i/j*-umlaut product of Proto-Norse *-wandja, and I encode this suffix accordingly consistently as [-endi] with the *i*-umlaut-product vowel [ɛ]. These etymological and phonological annotations provide us with a rich resource for the study of variation in sound–letter correspondences across scribes and texts. This enables us to triangulate on and differentiate potential etymological, phonological, and orthographic influences on surface spelling patterns. The etymological annotations are generated in R on a lexeme by lexeme basis using a combination of graphic

and morphological factors, as illustrated by the code in (81) for the corresponding *standa* ‘stand’ verb paradigm below in (82).

(81) Example annotation of root-initial vowels in *standa* ‘stand’ word forms

```

1  vh_df <- vh_df %>%
2    mutate (etym1 = replace (etym1, which (lemma == "standa"
3                                & tense == "preterite"
4                                & mood == "indicative"), "o:") ) %>%
5    mutate (etym1 = replace (etym1, which (lemma == "standa"
6                                & tense == "preterite"
7                                & mood == "subjunctive"), "ø:") ) %>%
8    mutate (etym1 = replace (etym1, which (lemma == "standa"
9                                & tense == "present"
10                               & number == "plural"
11                               & mood == "indicative"
12                               & person == "1. person"
13                               & v1 %in% c("a", "o")), "ɔ") ) %>%
14    mutate (etym1 = replace (etym1, which (lemma == "standa"
15                                & tense == "present"
16                                & number == "singular"
17                                & mood == "indicative"
18                                & v1 %in% c("e", "æ", "ǣ")), "ɛ") )

```

The method in (81) follows the same practice as illustrated in (78) but makes greater use of morphological annotations. For instance, if an elicited form of *standa* is preterite and subjunctive, the etymological value of the (stressed) initial vowel (etym1) is encoded as /ø:/ regardless of spelling: i.e. **stø:ðe* <stœðe, stœðe> ‘stand’-I.SG.PRET.SUBJ. For the sake of illustration, present/preterite indicative/subjunctive paradigms for the verb *standa* are provided below in (82), which contrast orthographic and etymological/phonological interpretations.

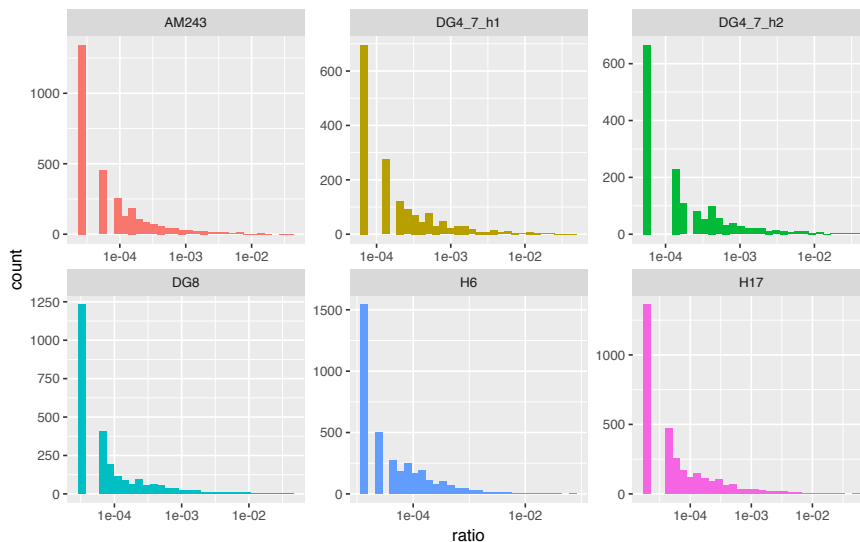
(82) Etymological vs. graphic representations of the *standa* ‘stand’ finite verb paradigm

Present indicative				Present subjunctive			
Singular		Plural		Singular		Plural	
1. * <i>stend</i>	<stænd>	* <i>støndum</i>	<standum>	* <i>stande</i>	<stande>	* <i>standem</i>	<standem>
2. * <i>stendr</i>	<stændr>	* <i>standet</i>	<standet>	* <i>stander</i>	<stander>	* <i>standet</i>	<standet>
3. * <i>stendr</i>	<stændr>	* <i>standa</i>	<standa>	* <i>stande</i>	<stande>	* <i>stande</i>	<stande>
Preterite indicative				Preterite subjunctive			
Singular		Plural		Singular		Plural	
1. * <i>sto:ð</i>	<stoð>	* <i>sto:ðom</i>	<stoðom>	* <i>stø:ðe</i>	<stœðe>	* <i>stø:ðem</i>	<stœðem>
2. * <i>sto:tt</i>	<stott>	* <i>sto:ðoð</i>	<stoðoð>	* <i>stø:ðer</i>	<stœðer>	* <i>stø:ðeð</i>	<stœðeð>
3. * <i>sto:ð</i>	<stoð>	* <i>sto:ðo</i>	<stoðo>	* <i>stø:ðe</i>	<stœðe>	* <i>stø:ðe</i>	<stœðe>

Due to constraints of time, I have written annotation-code like (81) for the 600 most frequent lemmas in the corpus, barring proper nouns whose written representations, as mentioned before, are typically significantly more idiosyncratic and challenging to account for using automated methods. Though this selection only accounts for 7.2% of Old Norwegian distinct lemmas, it covers over 80% of word-tokens since the Old Norwegian

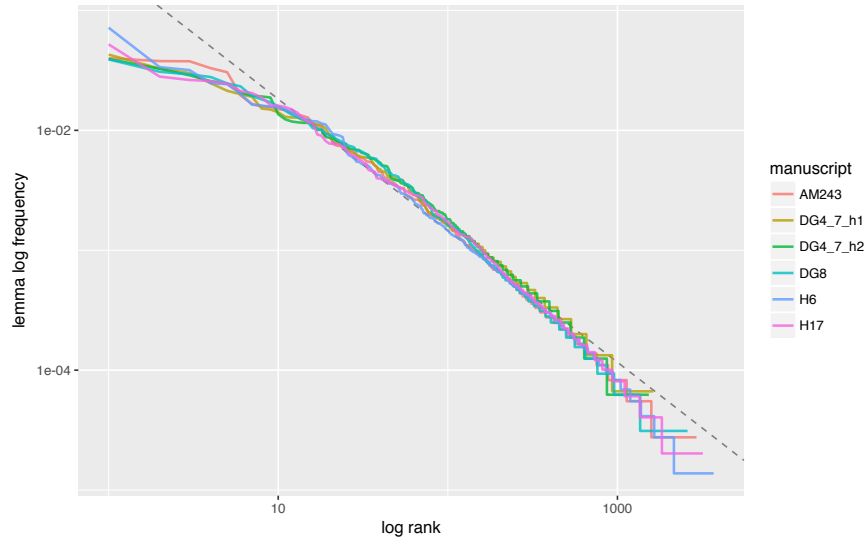
texts, like any natural language corpus, displays a zipfian distribution. Zipf’s law states that the frequency of any word (lemma) is inversely proportional to its frequency rank (Zipf 1935). In other words, in natural language, the most frequent word in a corpus will occur approximately *twice* as often as the *second* most frequent word; the *third* most common word will be about a *third* as common, and so on all the way down. The result of this is that 3,636 (44%) of lemmas in this corpus are *hapax legomena* – occurring only once in the entire corpus.

Figure 4.4: Lemma frequency ratios by manuscript



The word frequency ratios for each manuscript are provided in Fig. 4.4. Since the distributions are so skewed – where less frequent words are clustered around 0 and not graphically visible – I have log transformed the values to spread them out, making the results more interpretable. Nevertheless, they still display long right tails illustrating the stark inequality in word frequencies. This asymmetric distribution is expected and consistent among these manuscripts. The predicted zipfian relationship between frequency and frequency rank across the corpus can be best observed by plotting the log frequency rank order by log lemma frequency, as in Fig. 4.5. These log transformations spread out the skewed distribution, straightening out the line. Here I have fitted a simple regression line of lemma frequency based on frequency rank which approximates what would be a perfect zipfian distribution for comparison. The plot in Fig. 4.5 illustrates that word frequency distributions are very similar across all six scribes and that Zipf’s law approximately holds for this Old Norwegian corpus.

These stats suggest that word frequencies in the Old Norwegian corpus are in line with what we expect from a natural language corpus and that the 600 most common lemmas provide a suitably sized data set, capturing 83.4% (185534/222082 words) of the original corpus after eliminating proper nouns, foreign text, and heavily abbreviated material. This ought to be an appropriate sample for our present purposes. Acquisitional studies have found that children display few to no vowel harmony violations by around 2;6 years of age (MacWhinney 1978, Leiwo, Kulju & Aoyama 2002, Altan 2007), by which point the average child’s lexicon is estimated to consist of around 500 words (Barrett 1995). Accordingly, the size of vocabulary in this data set should approximate the size of the

Figure 4.5: A log-log plot of lemma frequency rank by frequency across manuscripts

vocabulary of a child which has completed vowel harmony acquisition and therewith be appropriate for analysing the principal characteristics of Old Norwegian vowel harmony.

This study's orthographic and etymological / phonological annotation code provides richly annotated and phonologically reliable data. These tools and resources allows us to study Old Norwegian vowel harmony and harmony variation in far greater detail and on much firmer footing than previous Old Norwegian vowel harmony research.

4.8 Summary

Because vowel harmony systems involve such intricate patterns and so many moving parts – e.g. varying vowels, feature classes, and morphological categories in varying morpho-phonological environments – quantitative corpus linguistic techniques have proven very useful in vowel harmony research. However, previous studies of Old Norwegian corpora have been nearly exclusively qualitative, and there are serious open questions about the reliability, consistency, and accuracy of Old Norwegian non-normalised orthography in representing phonological phenomena such as vowel harmony. In this chapter I have outlined the data collection and manipulation methods by which I have elicited vowel sequences from the digitised MENOTA corpus of roughly 185,000 words, collected from six scribes in five 13th-century manuscripts of various provenance. To investigate potentially competing orthographic, etymological, and phonological influences on Old Norwegian surface spelling patterns, I have developed a method to annotate graphic patterns for various phonological and etymological factors such as vowel etymology, quality, quantity, and phonetic environment. These components taken together provide a remarkably linguistically detailed corpus of Old Norwegian vowels and vowel height harmony patterns.

An abbreviated example of the most important variables in the dataframe is provided in (83). Proceeding from left to right, every word is tagged for its manuscript and a unique id. The **dipl** column represents the diplomatic transcription but without expanded abbreviations from which the vowel sequences are collected. For readability,

the abbreviated material is expanded and each word's corresponding lemma (dictionary entry form) are provided in the **expanded** and **lemma** columns. The column **seq_no** refers to the order in which vowels are collected: '1' is the initial vowel or vowel sequence, '2' is the first non-initial sequence, and so forth. The vowels' orthographic representations are recorded in **v1** / **v2** columns whereas their etymological or phonologically interpreted values are given in **etym1** / **etym2**, following the representations in Holthausen (1948). The relative height of each vowel is specified in **v1_high** / **v2_high**, which are logical variables ([+high] = TRUE; [-high] = FALSE). Finally, whether the vowel sequence is harmonic or not is recorded in **VH**, TRUE if **v1_high** = **v2_high**, FALSE if **v1_high** ≠ **v2_high**, and NA in monosyllabic data. The full, annotated dataframe – not represented here – includes additionally information on vowel backness, length, height class, and surrounding phonetic environment; part of speech, compound / non-compound status, and morphological parsings. This data set is available as a csv file online at <http://dx.doi.org/10.17613/gj6n-js33>.

(83) Examples from the etymologically annotated dataframe (abbreviated)

Ms.	id	dipl	expanded	lemma	seq_no	v1	v2	etym1	etym2	v1_high	v2_high	VH
H6	11857	stendr	stendr	standa	1	e	NA	ε	NA	F	NA	NA
H6	30331	støðe	støðe	standa	1	ø	e	ø:	e	F	F	T
H17	48957	støþe	støþe	standa	1	œ	e	ø:	e	F	F	T
H6	65048	hofðingianom	hofðingianom	hofðingi	1	o	i	ɔ	i	F	T	F
H6	65048	hofðingianom	hofðingianom	hofðingi	2	í	a	i	a	T	F	F
H6	65048	hofðingianom	hofðingianom	hofðingi	3	a	o	a	o	F	F	T
DG8	34024	kkunar	kirkiunnar	kirkia	1	u	a	u	a	T	F	F
H6	18773	giæva	giæva	giøf	1	æ	a	æ	a	F	F	T
H6	43804	giava	giava	giøf	1	a	a	a	a	F	F	T

The individual entries in (83) illustrate some key features of this study's data set. First, in contrast to studies which only consider polysyllabic forms (e.g. Hagland 1978a, Sandstedt 2014), I have collected vowels from both polysyllabic and monosyllabic words. This provides for a more detailed and accurate depiction of the vowel inventory and vowel frequencies examined in section 5.1. The polysyllabic data illustrate how each vowel sequence is treated individually and differentiated by its relevant sequence number – e.g. <o...í> {hofðing}1 ianom vs. <í...a> hof {ðingia}2 nom – allowing us to analyse harmony patterns in initial vs. non-initial sequences. The DG8 example <kkunar> demonstrates a form with abbreviated material from *kirkia* [kirkja] 'church'. Even though we expect that the root-initial vowel in this case would be [i] – as given in the expanded form – it is not always so obvious what the scribe would have written if he or she had written out the full form. Nevertheless, the transcriber must choose some representation in the expanded form, and to avoid the potential influence of such editorial choices I only make use of non-abbreviated material. The algorithm thus picks up the sequence <u...a> but not <i...u>.

Using this database, it is possible to study orthographic variation within and between scribes – e.g. H6 *j*-umlauted <giæva> vs. non-umlauted <giava> or simply orthographic variation such as H6 <støðe> vs. H17 <støþe> 'stand'-3.SG.PRET.SUBJ. In this way, we can analyse individual sound-letter correspondences precisely – e.g. H6 [ø:]–<ø> / [ð]–<ð> vs. H17 [ø:]–<œ> / [ð]–<þ>. This etymological–orthographic cross-referencing provides a rich resource for a wide variety of philological and phonological interests, such as studying vowel harmony and umlaut frequencies, the distribution of vowel contrasts and

mergers, and the consistency of Old Norwegian orthography between scribes and texts in relationship to a broad range of orthographic, etymological, and phonological factors.

Chapter 5

Old Norwegian grapho-phonology

Using the corpus methods outlined in the previous chapter, I provide a study of Old Norwegian grapho-phonology in this chapter – that is, the relationship between Old Norwegian sound and letter inventories. In section 5.1 I evaluate a number of factors which are known or suspected to contribute to variation in the consistency of vowel phonetic-graphic correspondences in Old Norwegian writing, such as inherent asymmetries in the Old Norwegian phonemic-graphemic inventory, ongoing vowel mergers, and the influence of certain sound processes on vowel spellings, such as various kinds of umlauts. An outline of the distribution of Old Norwegian vowels in different phonological and morphological positions is provided in section 5.2. The rest of the chapter is dedicated to a detailed corpus study of Old Norwegian vowel height harmony. I take a broad look at the distribution and decay of vowel harmony across this study’s manuscripts in section 5.3. On the basis of the oldest and most robust vowel harmony systems in the manuscripts DG8 and H6, I provide detailed generalisations of the principal characteristics of Old Norwegian vowel height harmony prior to harmony decay. In particular, I present the basic harmony and neutral harmony patterns in section 5.4, prosodic limitations based on syllable stress in section 5.5, the interaction of vowel height harmony with other processes such as vowel deletion and umlaut in sections 5.6/5.7. A final contrastive hierarchy analysis of these generalisations is provided in the following chapter 6.

5.1 Old Norwegian sound–letter correspondences

For the phonological mark-up of this study’s corpus data, I have assumed the Old Norwegian sound inventory – and dominant orthographic correspondences – in Table 5.1, adapted from Sandstedt (2017, p. 403) and consistent with the representations in Holthausen (1948). Old Norwegian displays an additional number of diphthongs which are treated separately in section 5.1.3. In this section, I provide an evaluation of the grapho-phonological correspondences of monophthongs in Table 5.1 and the phonological and orthographic factors which motivate spelling variation in Old Norwegian writing.

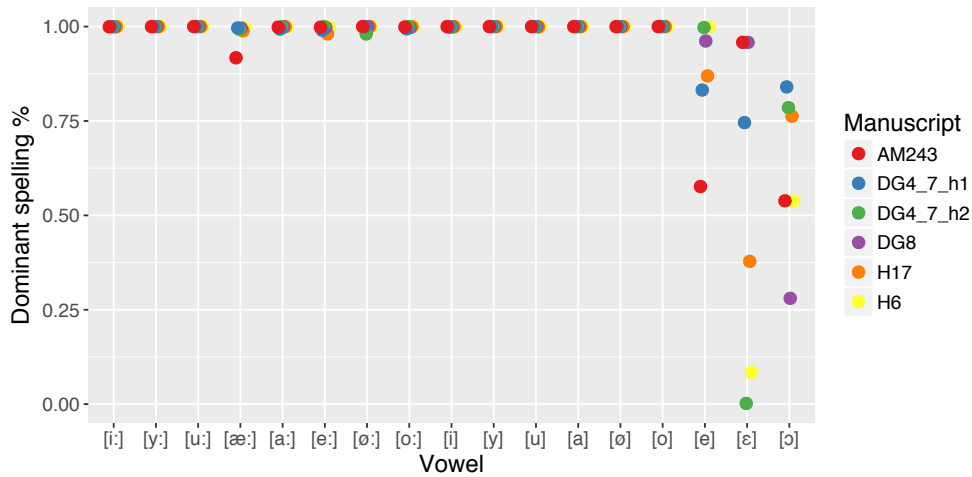
An examination of the consistency of Old Norwegian phonetic-graphic correspondences suggests the sound inventory and letter correlations in Table 5.1 are accurate. To provide an illustration of the consistency of sound–letter correspondences, I provide the proportion of each vowel’s dominant spelling in Fig. 5.1. This figure plots the relative proportion of each vowel’s most common spelling with or without diacritics (e.g. [e:] =

Table 5.1: Old Norwegian sound–letter vowel inventories

[i, i:]	<i>	[y, y:]	<y>	[u, u:]	<u>	HIGH
[e, e:]	<e>	[ø, ø:]	<œ>	[o, o:]	<o>	MID
[ɛ]	<æ, e>			[ɔ]	<o, a>	MID LAX
[æ:]	<æ>			[a, a:]	<a>	LOW

<e, é, ee>). There are a number of minor exceptions; [ø, ø:] has two (non-linguistically relevant) palaeographic variants – e.g. *oe*-ligatures and slashed-*o* <œ, ø, œ, ó> – which are not distinguished in Fig. 5.1. The vowels [ɛ, ɔ] have no unique corresponding spelling and are chiefly represented in writing by the letters of their nearest mid/low vowel neighbours [e, æ] and [o, a]. For these vowels, I have plotted these vowels’ dominant spellings in monosyllables (for the majority of scribes): i.e. [ɛ]–<æ> and [ɔ]–<o>, but predictably there is considerable variation in these vowels, as outlined below.

Figure 5.1: Short and long vowel dominant spelling frequencies



Among long vowels on the left in Fig. 5.1, there is generally a one-to-one sound-to-letter correspondence: e.g. 100% of the time [y:] is spelled <y, ÿ, ý>. The only potential exception is [æ:] in AM243 (0.92) whose lower frequency is due to <e>-spellings in the relatively frequent lexemes *gæ:ta* ‘watch’ and *a:-gæ:tr* ‘excellent’, which are exclusively represented as <geta> and <agettr> in AM243. This appears to indicate individual examples of an /æ:/ > /e:/ merger by transfer in this manuscript (that is, the lexically gradual but phonetically abrupt transfer of words from one phonemic category to another, cf. Labov 1994, p. 321; Seip 1955, pp. 148–50).

In contrast, among short vowels on the right of Fig. 5.1 there is considerable variation within and across manuscripts in the consistency of [e, ɛ, ɔ] vowel spellings. This variation is expected and traditionally has been attributed largely to three factors: non-unique sound–letter correspondences (Sandstedt 2017), ongoing vowel mergers (Hreinn Benediktsson 2004a), and orthographic confusion due to effects of *u*-umlaut (Hreinn Benediktsson 2004b). In the following sections, I explore this variation in detail, beginning with the back vowels.

5.1.1 [o, ɔ, a] – <o, a> phonetic–graphic correspondence

It is well known in Norse philological circles that [ɔ] or normalised short *ø* has no certain spelling in Old Norwegian writing. For example, in the H6 manuscript, the word *hɔfuð* ‘head’ occurs 32 times, and roughly 3 out of 4 cases display <a>-spellings as in NOM./DAT.SG. <hafuð, hafði> (25/32), 1 in 5 instances display <o>-spellings as in <hofuð, hofði> (6/32), and a single example features the digraphic spelling <haufuð>. Variation of this kind in non-high back vowels has been ascribed to chiefly three sources; namely, 1) phonemic–graphemic inventory asymmetries (i.e. [o, ɔ, a] – <o, a>), 2) /a/–/ɔ/ contrast neutralisation in *u*-umlaut (rounding) environments, and 3) possible vowel mergers (cf. Sandstedt 2017, Hreinn Benediktsson 2004b). Using this study’s phonologically –orthographically cross-referenced corpus, we can tease apart these factors and their contributions to [ɔ]-spelling variation. This corpus evidences that a base rate of variation is motivated by sound–letter inventory asymmetries, which is increased by /a/–/ɔ/ contrast neutralisation in *u*-umlaut environments as outlined below. There is no evidence of any mergers at this stage of the language.

Old Norwegian orthography has by and large only two letters for representing non-high back vowels; these are <o> and <a> which prototypically represented [o, o:] and [a, a:] vowels, respectively. [ɔ] is variably represented by both letters and less frequently by a variety of ligatures (e.g. <æ>, <ɔ>, etc.) and digraphic spellings (e.g. <au>, <ao>, etc.). It has historically been unclear to what extent the lack of a [ɔ]-unique letter simply represents ‘a shortcoming of the writing system’ or a possible merger of /ɔ/–/o/ vowels (cf. Hreinn Benediktsson 2004b, p. 155). /o, ɔ/ have merged in later Norwegian – cf. Modern Norwegian *brodde* ‘put on barbs’ vs. *hogge* ‘chop’ and Old Norwegian *brodda* vs. *hoggva* – but the chronology and geography of this merger is unclear at this time. To evaluate the possibility of a merger, let us first consider <o, a> spellings in non-*u*-umlaut contexts (that is, not before a following <u> or <o>; for example [‘hɔfði] <hafði, hofði> ‘head’-DAT.SG.). Since it is known that *u*-umlaut affects [ɔ]-spellings, these are considered separately further below.

Figure 5.2: <o, a>-spellings for [o, ɔ, a] vowels in non-*u*-umlaut environments

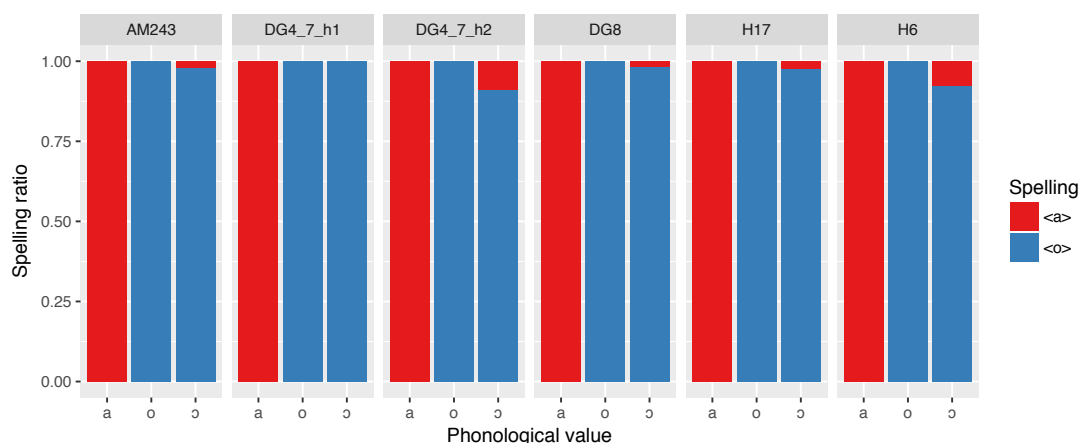
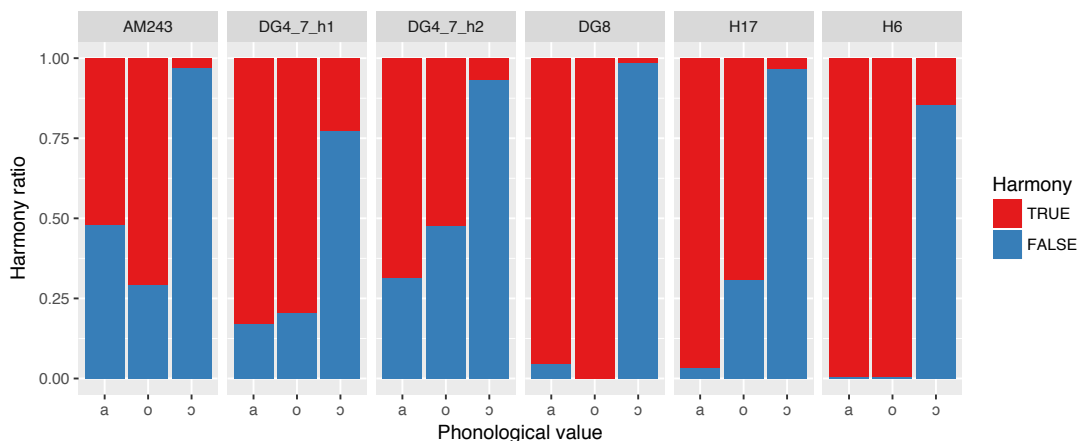


Fig. 5.2 provides a plot the <a, o>-spelling ratios for [a, o, ɔ] vowels in each manuscript in non-*u*-umlaut environments. This shows that <a, o> spelling variation is strictly asymmetric. Across the corpus, spelling variation only affects the [ɔ] vowel. 100% of the time [o] is spelled <o> (15,760), and [a] is spelled <a> (41,536 spellings). It is only

[ɔ] which displays any variation with 1,878 <o>-spellings but 88 <a>-spellings across the corpus in non-*u*-umlaut environments. While there is variation, the vast majority of (non-derived) /ɔ/ vowels are spelled <o>. These data suggest a number of possibilities. Most particularly, it may suggest that /o, ɔ/ have merged, but in this case it is surprising that there is no symmetric [o]-spelling variation. In cases of authentic merger (e.g. /e, ε/ in section 5.1.2), we normally observe overlapping spelling variation in both directions which is clearly lacking in this case. An alternative possibility, as I have argued elsewhere (cf. Sandstedt 2017), is that this asymmetric variation simply represents a shortcoming of Old Norwegian orthography – displaying only two <a, o> graphic distinctions with which to represent three [a, ɔ, o] vowel distinctions. This latter possibility is supported by the asymmetry of spelling variation observed in Fig. 5.2 and by the differing phonological patterning of /o, ɔ/ vowels. Despite being generally orthographically indistinct, these vowels display differing vowel harmony and neutral harmony patterns, as illustrated below in Fig. 5.3 which plots the ratio of height harmony triggered by each vowel in root-initial positions.

Figure 5.3: [o, ɔ, a] height harmony frequencies in potentially harmonising contexts



Though there is variation in harmony frequencies in Fig. 5.3 as a reflection of ongoing harmony decay (see section 5.3), the distinction between historically harmonic /a, o/ and historically neutral /ɔ/ vowels is persistent in every manuscript. In Fig. 5.3, I provide each vowel's harmony ratio in potentially harmonising contexts – that is, initial vowel sequences consisting of [a, o, ɔ] V_1 -vowels and potentially harmonising, unstressed [i, e, u, o] V_2 -vowels. On average across the corpus, 87.12% (3139/3603) of potentially harmonising [a...V] sequences and 83.43% (1153/1382) of [o...V] sequences are harmonic in comparison to only 7.82% (301/3847) of [ɔ...V] sequences. In other words, despite overlapping <o>-spellings, the distinct phonological behaviour of /a, o, ɔ/ vowels suggests that these vowels remained distinct for each of the scribes in this corpus. In sum, the spelling and harmony distributions for [a, o, ɔ] vowels in Figs. 5.2/5.3 can be best understood as a function of the basic asymmetry between Old Norwegian phonetic-graphic inventories. Old Norwegian scribes had three distinct vowel qualities [a, ɔ, o] but only two letters <a, o> with which to represent them. The result is variation on [ɔ], spelled both <o, a>.

This underlying spelling asymmetry is increased in *u*-umlaut environments. The patterning of Old Norwegian *u*-umlaut is discussed in greater detail in sections 5.6/6.4, but for our present purposes, it will suffice to say that synchronic Old Norwegian *u*-

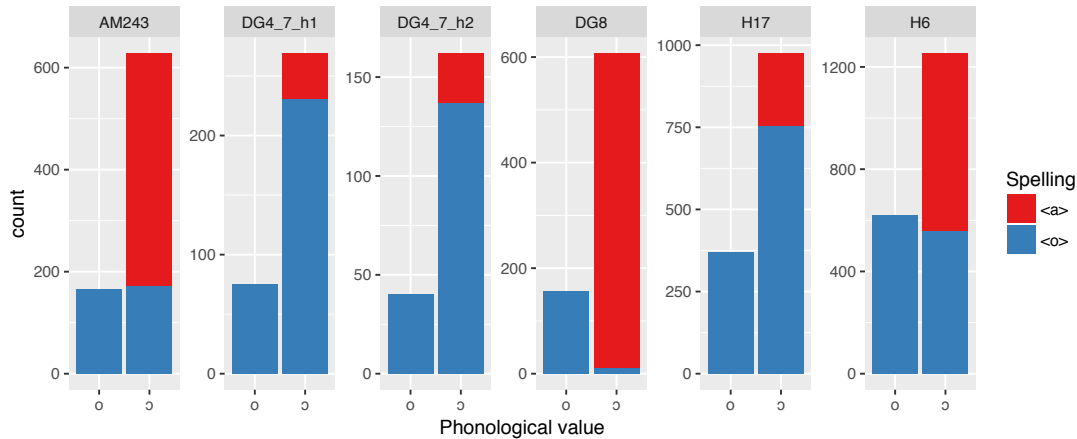
umlaut involves rounding /a/→[ɔ] before a following [u], resulting in [a, ɔ] alternations as illustrated in (84) with data taken from the H6 manuscript. As shown in (84), Old Norwegian displays a contrast between /a, ɔ/ in monosyllables – [ˈvald] <valld> vs. [ˈhɔnd] <hond> – which is neutralised before a following [u]: e.g. [ˈvɔldum] <valldum, vollдум> vs. [ˈhɔndum] <handum, hondum>.

(84) /a/-/ɔ/ and <a>-<o> distinctions are neutralised before a following /u/

a.	'barn	<barn>	'bɔrn-um	<barnum, bornum>	'child'-NOM.SG./DAT.PL.
b.	'vald	<valld>	'vɔld-um	<valldum, vollдум>	'power'-NOM.SG./DAT.PL.
c.	'grɔf	<grof>	'grɔf-um	<grafum, grofum>	'grave'-NOM.SG./DAT.PL.
d.	'hɔnd	<hond>	'hɔnd-um	<handum, hondum>	'hand'-NOM.SG./DAT.PL.

U-umlaut has a profound effect on [ɔ]-orthography, generally markedly increasing <o, a>-spelling overlap in [ɔ...u] environments. These *u*-umlaut spelling effects hold regardless of whether the vowel is an underlying /a/ (84ab) or an underlying /ɔ/ (84cd). In comparison to non-*u*-umlaut contexts (Fig. 5.2), we find considerably more spelling variation across scribes in *u*-umlaut environments, as illustrated in Fig. 5.4. In Fig. 5.4, only [o] and [ɔ] vowels are plotted since [a] does not regularly occur in this environment – being regularly rounded to [ɔ].¹

Figure 5.4: <o, a>-spellings for [o, ɔ] vowels in *u*-umlaut environments



In Norse philology, the accepted interpretation of increased [ɔ]-spelling variation in *u*-umlaut environments, following Hreinn Benediktsson (2004b), is that the underlying vowel is underspecified for rounding and that *u*-umlaut rounding is gradient. The argument goes that since the opposition between [ɔ]–[a] is effectively neutralised in positions before a following [u], Norse speakers represented [ɔ] before [u] as an archiphoneme [A] (*ǰ* in Hreinn’s notation), which is underspecified for rounding: e.g. /hAfuð/ ‘head’. The phonetic realisation of [A] is presumed to be dialectally variable, with greater or lesser rounding as evidenced by greater or lesser round <o>-spellings across

¹The only exception to this generalisation is rare /e/- or /i/-blocking of *u*-umlaut and subsequent /e, i/-deletion in definite enclitics, which results in [a–u/o] vowel sequences (see section 5.7): e.g. /ˈfja:nd-a-enum/→[ˈfja:nd-a-nom] <fiandanom> ‘fiend’-DAT.SG.-DEF.DAT.M.SG. In such positions, *u*-umlaut does not occur, and /a/ (uniformly spelled <a>) triggers height harmonic lowering. These contexts are, however, textually very rare.

Norwegian writers, as illustrated in Fig. 5.4. As summarised by Hreinn Benediktsson (2004b, p. 426):

Since...the opposition usually represented by the symbols ‘a’ and ‘o’ had no more distinctive function here than otherwise before *u*, the choice of symbol was unimportant, and the greater degree of rounding was, as a rule, denoted only sporadically.

However, it is not obvious that we need to assume some gradient spectrum of rounding or archiphonemic representations to explain these orthographic patterns. I argue conversely that variable [ɔ]-spelling can be simply understood as an effect of the relationship between phonetics and orthography. There is already a base rate of variation in [ɔ]-spelling due to the [o, ɔ, a]–<o, a> asymmetry in Old Norwegian sound–letter inventories (cf. Fig. 5.2), which is boosted in *u*-umlaut environments as a result of the neutralisation of /a/–/ɔ/ contrasts (cf. Fig. 5.4). In other words, non-unique spelling is a predictable outcome of non-unique sound-to-letter correspondences. In ambiguous *u*-umlaut contexts, either <a, o>-spelling for [ɔ] is effectively equally valid (or equally bad), regardless of the underlying vowel since /a, ɔ/ are generally not contrastive before a subsequent [u]. Due to the shortcoming of the Old Norwegian writing system, the orthographic choice between <a>–<o> for short vowels before an unstressed [u] is therefore fairly inconsequential – it must regardless represent [ɔ]. Thus, even though the spellings are unpredictable, their phonetic interpretation is not. What remains in question is what motivates higher and lower frequencies of one spelling variant over another across Old Norwegian scribes.

As shown in comparing the two previous Figs. 5.2/5.4, scribes appear to display differing orthographic conventions. Some scribes appear to follow a fairly robust orthographic rule that [ɔ] should be spelled <a> before [u] but <o> elsewhere (e.g. DG8/AM243). Other scribes, such as H6, do not seem to follow a fast rule for *u*-umlaut spellings, with nearly 50/50 <o, a> spellings in /ɔ, a/-contrast-neutralising (*u*-umlaut) contexts. Finally, for other scribes, <o, a>-spelling frequencies are not considerably affected by *u*-umlaut (e.g. DG4_7_h1, DG4_7_h2, H17). Though each of these latter three scribes do display an increase of <a>-spellings in [ɔ...u] contexts, the increase is markedly less than for other scribes – implying that for these scribes, [ɔ] should generally be spelled as <o> in and outside umlaut contexts. The frequency variation in Fig. 5.4 seems therefore to reflect by and large different orthographic solutions to the common problem of having no unique letter for [ɔ]: scribes either represent *u*-umlauted [ɔ] generally as <a> (DG8, AM243), <o> (DG4_7_h1, DG4_7_h2, H17), or both (H6).

Each of these writing systems are equally valid approaches to the basic problem of phonetic–graphic asymmetries. Since these cases of spelling variation can be interpreted as simple orthographic variation, there is not sufficient evidence to suggest that variation in <a, o> relative frequencies in *u*-umlaut contexts are phonetically rooted in Old Norwegian. That is, contra Hreinn Benediktsson (2004b), such variation is not necessarily indicative of gradient or variable rounding.²

²It may also be noted that comparative and phonological evidence further suggests Old Norwegian *u*-umlaut [a, ɔ] alternations are categorical. As I discuss further in section 5.4.2, though the spelling may be variable, [ɔ] is categorically a neutral blocker of height harmony whether underlying or derived via *u*-umlaut: e.g. [‘orrɔst-u] <orrastu, orrostu>, not *[‘orrɔst-o]. Moreover, the parallel version of *u*-umlaut

In sum, there is considerable variation in the representation of the lax mid vowel [ɔ], but the sources of this variation are well-understood and do not inhibit this vowel's identification or phonological analysis. Variation in [ɔ]-orthography can be understood as the aggregate effect of phonemic–graphemic inventory asymmetries and increased orthographic overlap reflecting the general lack of /ɔ/–/a/ contrasts in *u*-umlaut environments. A close inspection of these vowels' spelling frequencies reveal that scribes adopt slightly different orthographic solutions to the problem of non-unique phonetic–graphic correspondences but display generally identical [a]–[ɔ] morphophonological distributions.

5.1.2 [e, ɛ] – <e, æ> phonetic–graphic correspondences

There is considerable variation in the representation of historical short **e* and **ɛ* vowels. These are commonly called 'original' and 'umlaut' *e*, respectively, since this distinction is not represented in normalised Old Norse orthography and because **ɛ* is most commonly the product of *i*-umlauted **a* – e.g. *senda* < **sandijan* 'send'. The chief source of [e, ɛ] spelling variation in Norse textual material is the result of these vowels' merger, leading to the eventual loss of **e*/**ɛ* orthographic distinction. In the way of an example, consider the data in (85). The manuscript DG8 consistently distinguishes historical **e* and **ɛ* vowels via distinct <e, æ> spellings in comparison to the H6 manuscript which with very few exceptions represents both vowels as <e> regardless of their etymology. In other manuscripts, the merger of these vowels may lead to considerable spelling overlap. For example, the word **veg-sæmd* 'glory, honour' which displays both vowels is spelled variably in the H17 manuscript as <vægsæmð, vægsemð, vegsemð, vëgsæmð>; that is, either **e*/**ɛ* vowel can be spelled as either <æ, e>. This merger occurred in one form or another across all Norse dialects over the 12th–14th-centuries.

(85) (Non-)etymological **e*/**ɛ* spellings in Old Norwegian manuscripts

DG8 – c (1225–50)	[e, ɛ] – <e, æ>		
<i>*e</i> <g <u>e</u> v-e>	'give'–3.SG.PRES.SUBJ.	<re <u>k</u> -et>	'drive'–PRET.PART.
<i>*ɛ</i> <h <u>æ</u> v-i>	'have'–3.SG.PRES.SUBJ.	<t <u>æ</u> k-it>	'take'–PRET.PART.
H6 – c (1275)	[e, ɛ] – <e>		
<i>*e</i> <g <u>e</u> v-e>	'give'–3.SG.PRES.SUBJ.	<re <u>k</u> -et>	'drive'–2.PL.IMP.
<i>*ɛ</i> <h <u>e</u> v-i>	'have'–3.SG.PRES.SUBJ.	<te <u>k</u> -it>	'take'–PRET.PART.

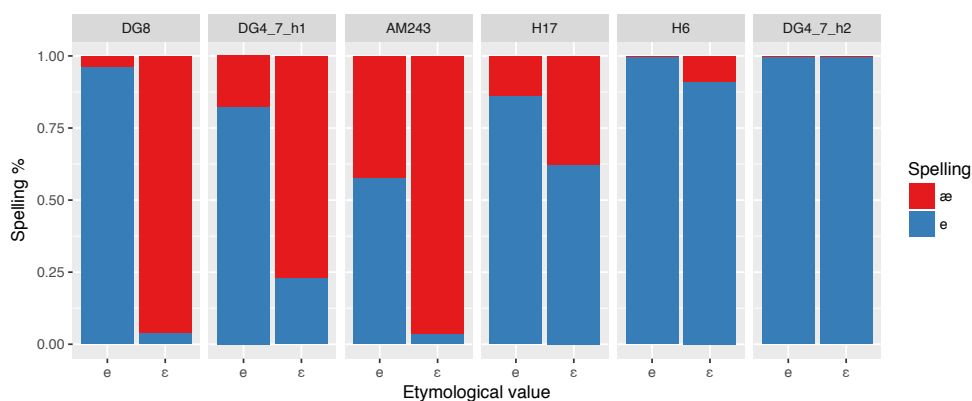
A detailed analysis of these mergers exceeds the scope of this thesis; but see [Hreinn Benediktsson \(2004a\)](#) for a detailed overview. For the study of Old Norwegian vowel harmony, there are two factors which I wish to focus on here. First, it is reported in philological literature that **e*/**ɛ* vowels display differing harmony behaviours in Old Norwegian (see section 5.4.2). As shown in (85ab), **e* is historically harmonic (e.g. [geve]) while **ɛ* is historically harmonically neutral (e.g. [hevi], not *[heve]). To provide a sufficient basis for exploring these contrasting **e*/**ɛ* harmony patterns, I provide quantitative confirmation of the /e/ and /ɛ/ contrast in the harmonic manuscript DG8.

found in Modern Icelandic is categorical, not gradient (Gibson & Ringen 2000; cf. Kristján Árnason 2011, ch. 11).

Second, several philologists have made the peculiar assertion that even though there is no difference in their spelling, some scribes uphold the $*e/*\varepsilon$ contrast as evidenced by these distinctive harmony patterns (e.g. Hægstad 1907, pp. 30–32; Rindal 1987; Grønvik 1998). Such a case is exemplified by the H6 manuscript. Both DG8/H6 manuscripts display consistent and robust vowel harmony systems (see section 5.3), and though the H6-scribe generally represents both $*e/*\varepsilon$ vowels as <e> regardless of their etymology, vowel harmony in this manuscript appears to be etymologically rooted (85cd): i.e. historical $*e$ is consistently height harmonic (e.g. <geve>) while historical $*\varepsilon$ is height disharmonic (e.g. <hevi>, not $*\langle\text{heve}\rangle$). In other words, despite the lack of orthographic distinction, the original contrast is still recoverable in such texts from the vowels' distinctive phonological patterning. Why scribes sometimes display distinctive harmony patterns despite non-distinctive orthography is an unresolved philological puzzle.

The data suggest a number of possibilities. One possibility is that /e, ε / are phonologically distinct in H6 but orthographically non-distinctive (Hægstad 1907, Rindal 1987). In this case, harmonic correspondence in following syllables may act as a kind of diacritic spelling. In other words, in harmonising contexts the vowel distinction is overtly represented in writing by the presence or absence of harmony: e.g. harmonic $*e$ ['ber-e] <bere> 'carry'-SUBJ.PRES.3.SG. vs. height disharmonic ['ber-i] <beri> 'fight'-IMP.PL. This raises the question why scribes who distinguish /e, ε / did not represent the contrast in spelling. Another possibility is that /e, ε / have merged but the vowel harmony rules were lexicalised and remain therefore etymologically rooted (cf. Hreinn Benediktsson 2004a; Kristoffersen & Torp 2016). In this case, historically allophonic height harmonic [-i, -e] alternations became fixed prior to the /e, ε / merger. If this is correct, then the suffixes are contrastive for height in H6 (i.e. /-i, -e/) and indirectly indicate the historical value of preceding vowels since their distribution still closely resembles their original allophonic patterning: e.g. /'ber-e/ <bere> 'carry'-SUBJ.PRES.3.SG. vs. height disharmonic /'ber-i/ <beri> 'fight'-IMP.PL. This possibility raises quite a number of questions about the nature of harmony processes, their decay/lexicalisation, and the likely effects of merging historically distinct harmonic and neutral vowels.

Figure 5.5: <æ, e>-spellings for short [e, ε] vowels in root-initial positions



Before examining these alternative interpretations in more detail, I provide a general picture of the consistency of etymological $*e/*\varepsilon$ – <e, æ> spelling distributions in word-initial syllables across each manuscript in Fig. 5.5. We observe a broad spectrum from

clearly contrasting scribes such as the writer of DG8 on the left to non-contrasting manuscripts on the right such as DG4_7_h2.

To assess the degree of merger across the manuscript corpus, I have coded the data for a number of environments which Hreinn Benediktsson (2004a) has identified as potential merging contexts. The relevant environments are outlined in Table 5.2 below. For historical reasons, there are few to no /e, ε/ contrasts in [_Cj] and [_NC] contexts. In these positions, Germanic **e* raised to *i*: e.g. *binda* ‘bind’ < **bendan* or *vilja* ‘want’ < **weljan* vs. *velja* < **waljan* or *senda* ‘send’ < **sandijan*. In the other contexts, either /e/ or /ε/ may occur. The final category [_SC] includes specific consonant clusters, primarily including a spirant + plosive (specifically, [ft, fsk, fst, st, ss, sk]).

Table 5.2: Etymological distribution of /e/

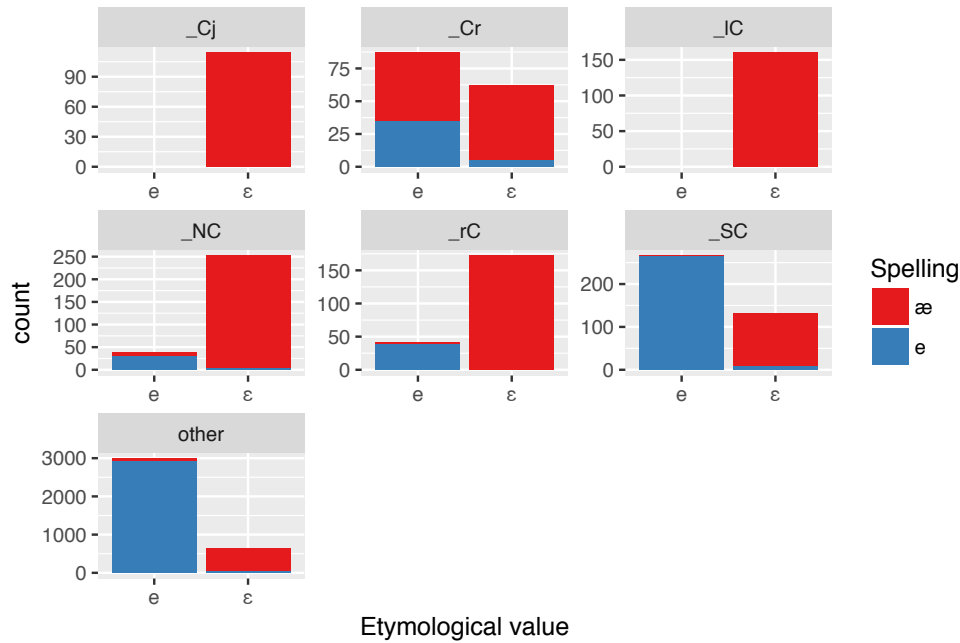
_Cj	before consonant + <i>j</i>	<bæria, rekkia, segium, tuægga>
_Cr	before consonant + <i>r</i>	<bætr, gefr, meþr, tækr>
_lC	before liquid + consonant	<duelz, hællðr, tælr, ælska>
_NC	before nasal + consonant	<ængi, hænnðr, kuikuenndi, længst>
_rC	before <i>r</i> + consonant	<berr, gerðe, hværrt, klærkr>
_SC	before certain clusters	<hefzc, hestr, þessi, æftir>

The distribution of <e, æ> spellings for **e*/**ε* in DG8 in each of the above contexts is provided in Fig. 5.6. These data largely confirm the etymological distribution of /e, ε/ vowels. The only considerable deviation is found before a consonant + rhotic. In these [_Cr] contexts, we see clear evidence of an ongoing *e* > *ε* merger, where roughly 62% of historical **e* are spelled <æ>: e.g. historical **vetr-om* ‘winter’-DAT.PL is spelled <vætrum>, and not *<vetrom>. The DG8 manuscript thus by and large upholds the historical /e, ε/ contrast and corresponding harmony patterns. Since DG8 displays robust vowel harmony (see section 5.3), this manuscript provides a secure basis for examining the divergent harmony behaviours of /e, ε/ vowels (explored further in section 5.4.2).

If we contrast Fig. 5.6 with the corresponding spelling data from H6, we see that the H6 manuscript displays more or less no **e*/**ε* spelling distinction. The only exception is preceding/following ‘l’, as in the textually frequent lemmas *bleza* <blæza> ‘bless’, *elska* <ælska> ‘love’, and contracted forms of *heilagr* ‘holy’ such as the NOM.F.SG. [hælgə] <hælgə>. In all other contexts, there is no [e, ε] orthographic distinction in H6.

Historical **e*/ε vowels, however, have historically distinct harmony patterns, where original **e* is a height harmony trigger while umlaut **ε* is not: e.g. [‘gev-e] vs. [‘hæv-i]. If we examine the harmony patterns following **e*/**ε* in the same contexts in H6, we observe a near categorical distinction on par with those we observe in DG8, regardless of their spelling. In other words, while H6 displays no general **e*/**ε* orthographic distinction, these vowels are distinguished by their harmony patterns. This is illustrated in Fig. 5.8 which plots the number of harmonic vs. disharmonic sequences in H6 in forms with potentially harmonising *V*₂-[i, e, u, o] vowels in each phonetic environment following *V*₁-[e, ε]. These data demonstrate that while the H6 scribe displays no regular **e*/**ε* distinction in spelling, this contrast is clearly distinguished in phonological behaviour, as evidenced by distinct harmony patterns. The only exceptions are in the [_rC] and [_NC] environments. In [_rC] contexts, roughly 90% of historical **e* are height disharmonic: e.g. historical **ger-ðe* ‘do’-3.SG.PRES. is represented as <gerði>, not *<gerðe>. In contexts

Figure 5.6: DG8 <æ, e>-spellings for short [e, ɛ] vowels by phonetic environment



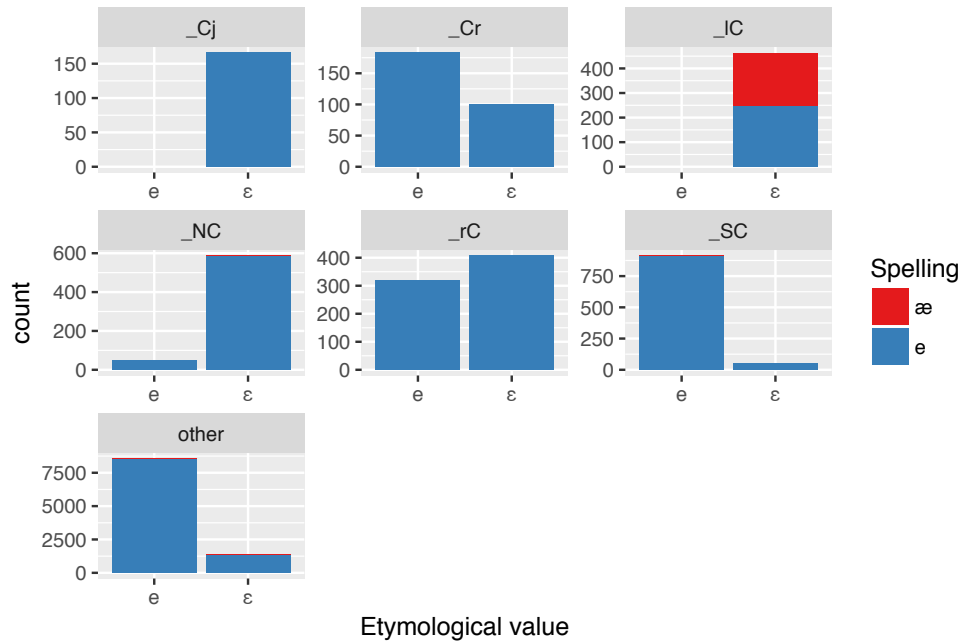
preceding a nasal + consonant, there appears to be the beginnings of an $\epsilon > e$ merger, where a bit less than a third of historically, disharmonic $*\epsilon$ vowels are height harmonic: e.g. historical, disharmonic $*\epsilon ng-u$ ‘none’-DAT.N.SG. is represented harmonically as <engo>, not $*\langle engu \rangle$. In other contexts – as in DG8 – there is clearly a categorical distinction.

These data provide quantitative confirmation that some scribes display $*e/*\epsilon$ etymologically rooted, distinctive harmony patterns despite the lack of a corresponding orthographic contrast. In nearly all contexts, the $*e/*\epsilon$ contrast is not distinguished in writing in H6. However, a comparison of H6 $*e/*\epsilon$ harmony patterns demonstrates coherent/distinct examples of both contrastive and merging contexts. The regularity of H6 contrastive $*e/*\epsilon$ harmony patterns therefore strongly supports the hypothesis that these vowels are contrastive, just not orthographically distinguished (cf. Hægstad 1907, pp. 30–32; Rindal 1987; Grønvik 1998).

Why H6 does not display distinctive spelling patterns like DG8 is not immediately clear. One possibility is that this is another effect of the asymmetric graphemic–phonemic inventory in Old Norwegian. As with the back vowels [o, o:, ɔ, a, a:] – <o, a>, Old Norwegian displays a parallel asymmetry between sound-letter inventories among front vowels – i.e. [e, e:, ɛ, æ:] – <e, æ> – with the exception that Old Norwegian does not display a short, front /æ/ underlyingly.³ In any case, if the H6 scribe treats short and long vowel phonemic–graphemic distinctions separately, then this would predict [e, ɛ] vowels would be represented identically. This is illustrated by the corresponding short and long non-high vowel phonemic/graphemic inventories below in (86).

³Short [æ] is sometimes derived via palatalising *j*-umlaut; see section 5.6.

Figure 5.7: H6 <æ, e>-spellings for short [e, ɛ] vowels by phonetic environment



(86) H6 short and long vowel sound–letter correspondences

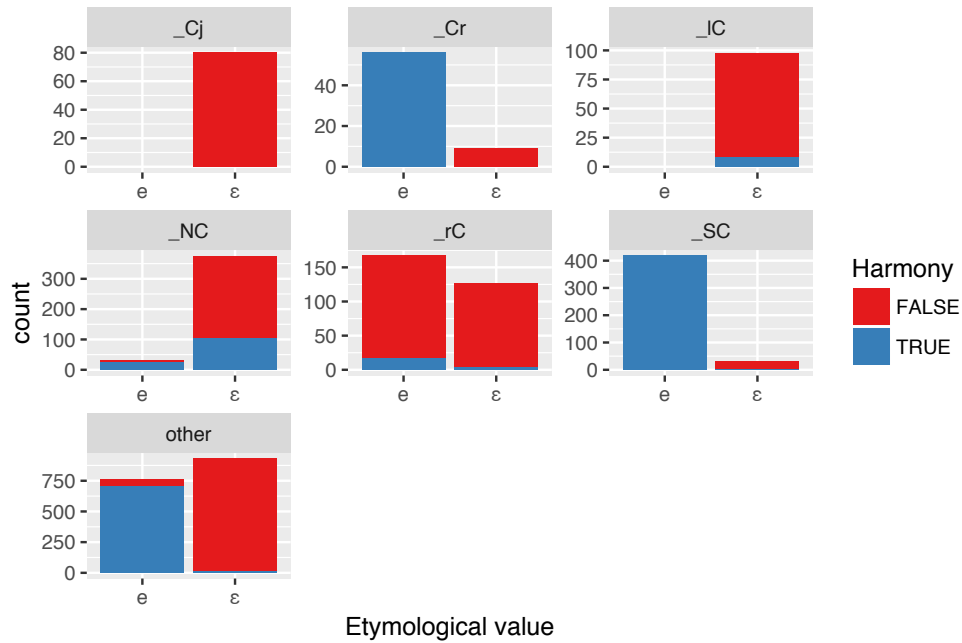
e	<e>	< o>	o	e:	<e>	<o>	o:
ɛ	<e>	<a o>	ɔ	æ:	<æ>	<a>	a:
		<a >	a				

This interpretation of H6 asymmetric spelling distinctions is consistent with the back vowel variation observed in section 5.1.1. As shown in (86, 87), there is a three-to-two sound-to-letter correspondence [o, ɔ, a] – <o, a> but only two-to-one sound-to-letter correspondence in front vowels [e, ɛ] – <e>. This predicts spelling variation in back vowels – e.g. <folldi, fialldi> for [ˈfɔldi] – which is lacking amount front vowels – i.e. [ˈgɛngit] <gengit>, never *<gængit>.

(87) H6 *ɛ/*e – <e> and *ɔ – <a, o> spelling variation

<gevet>	[ˈgevet]	‘give’-PP.	<folldi>	[ˈfɔldi]	‘multitude’-NOM.SG.
<gevet>	[ˈgevet]	‘give’-PP.	<fialldi>	[ˈfɔldi]	‘multitude’-NOM.SG.
<gengit>	[ˈgɛngit]	‘walk’-PP.	<hofðingia>	[ˈhɔfðingia]	‘chief’-ACC.SG.
<gengit>	[ˈgɛngit]	‘walk’-PP.	<hafðingia>	[ˈhɔfðingia]	‘chief’-ACC.SG.

In summary, [e, ɛ] vowels display a great deal of orthographic variation across Old Norwegian manuscripts. The primary source of this variation is the ongoing or completed merger of these vowels across Old Norwegian dialects. A detailed study of this merger is beyond the scope of this thesis, but I have explored the distribution of these two vowels in this corpus’s two vowel harmony manuscripts DG8/H6. DG8 displays both distinct orthographic and vowel harmony patterns. H6 on the other hand displays a peculiar pattern where the /e, ɛ/ contrast is not represented by distinctive spelling but can be established by distinctive harmony patterns. From this it follows that in Old Norwegian,

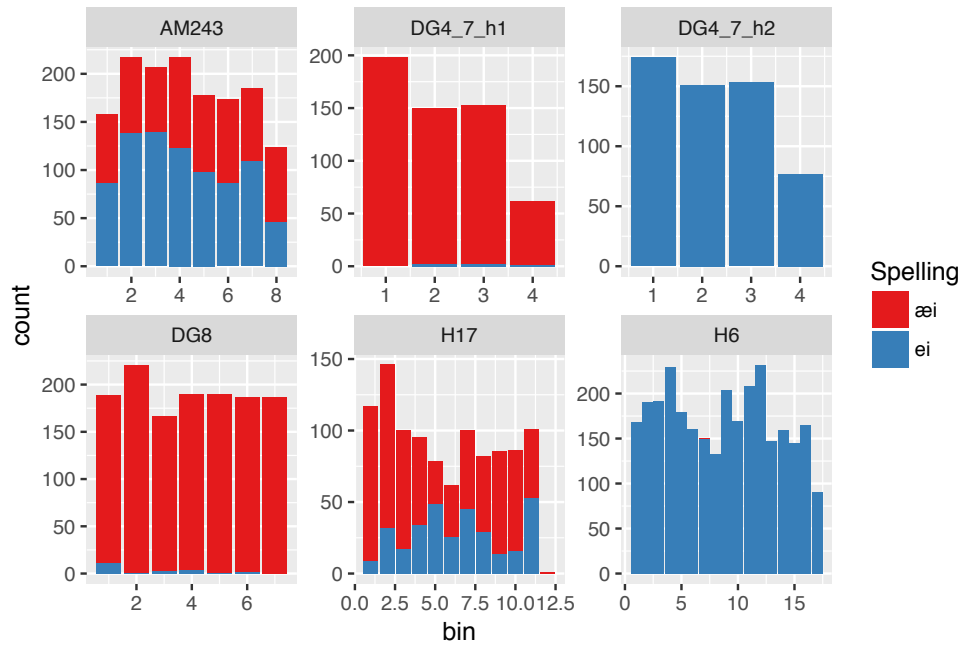
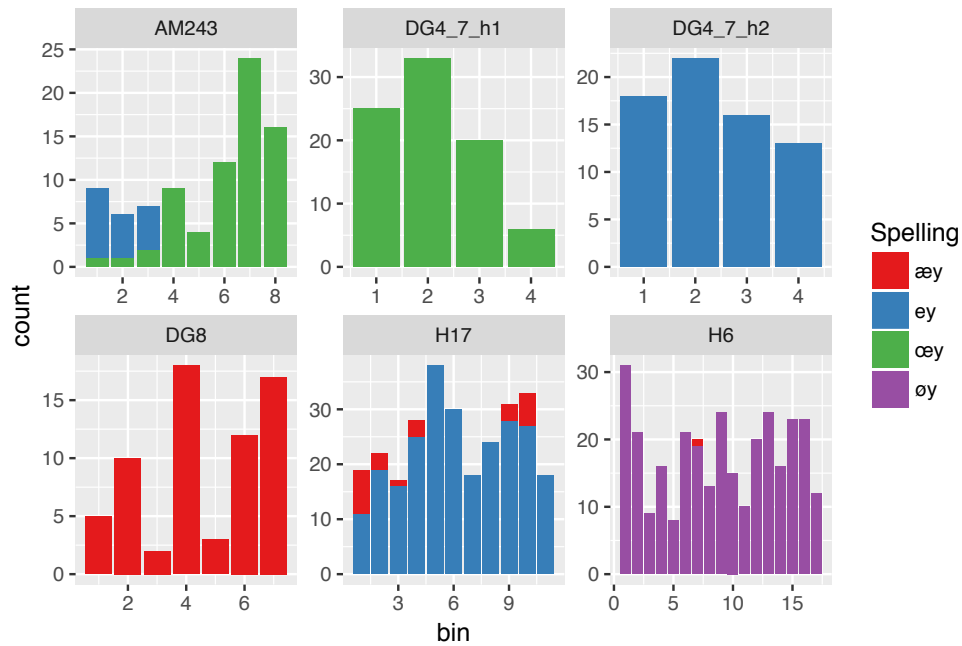
Figure 5.8: H6 **e/*ε* harmony patterns by phonetic environment

the **e/*ε* merger can only be satisfactorily established by a combination of orthographic and phonological criteria. The absence of orthographic distinction does not necessarily indicate the lack of phonological distinction.

5.1.3 Diphthongal phonetic–graphic correspondences

Old Norwegian displays three diphthongs – *au*, *ei*, *ey* in normalised Old Norse orthography. The realisation of diphthongs in Old Norwegian writing varies considerably dialectally. As a starting point to which we may compare, the DG8 scribe represents these three diphthongs as <au, æi, æy>. The first diphthong <au> is consistently spelled <au>/<av> across the corpus: e.g. DG8 ['braut] <braut, bravt> ‘road’-ACC.F.SG. I interpret this diphthong as [au], but since [ɔ] is typically spelled <a> before a following [u], it is also possible the diphthong was realised as [ɔu]. In any case, there is no variation between scribes in the written representation or the phonological behaviour of this diphthong. In comparison, there is considerable variation in the spelling of the remaining two diphthongs.

The spelling of the nuclear element of normalised *ei* generally mirrors the representation of /ε/ in each manuscript; that is, varying chiefly between <æi, ei>: e.g. ['beɪða] <bæiða, beiða> in DG8/H6, respectfully. For this reason, I interpret this diphthong as [ei] and/or [ei] for scribes who are undergoing or have fully merged the /e/–/ε/ vowels. In Fig. 5.9a, I have plotted the ratio of <ei, æi> spellings in samples of 4000 words in each manuscript. This shows that the variation in AM243/H17 is stable across the manuscripts – consistent with the assumption that their variation is an effect of ongoing/completed mergers and/or [e, ε, æ] – <e, æ> phonetic–graphic asymmetries.

Figure 5.9: Binned plots of *ei/ey* spellings by manuscript(a) *ei* – <æi, ei>(b) *ey* – <æy, ey, øy, øey>

The representation of normalised *ey* is somewhat more complex. As I show in Fig. 5.9b, there is chiefly variation between two types, a round <øy, øey> and non-round <æy, ey>. The round vowel graphs <ø, øe> are not contrastive in Old Norse writing (cf. Hreinn Benediktsson 2004c) and are simply palaeographic variants for a front, mid rounded vowel. Depending on the scribe's dialect then, this diphthong likely varied between [øy, ey, ey]. As with [ei], the spelling of the nuclear element of normalised *ey* matches [ɛ] for DG8

(i.e. [ɛy] – <æy>). AM243, H6, and DG4_7_h1 display in general round [øɣ]. There is some <ey, œy> spelling variation in the beginning of AM243. More detailed study of this manuscript is required to establish what the source of this variable spelling is, but isolated variation of this kind may indicate copying influence in the beginning of the codex. The <ey> spellings in DG4_7_h2 and H17 could arguably be interpreted as either [ɛy, ey].

In sum, Old Norwegian displays three contrastive diphthongs, whose phonetic and orthographic realisation seem to vary – chiefly between [au, ei, ɛy] as in DG8 and [au, ei, øy] as in H6; Norwegian scribes display variable <æi, ei> – [ei], <æy, ey> – [ɛy], and <øy, œy> – [øɣ] spellings. A much broader survey of Norwegian material is required to establish the ultimate chronological/geographic distribution of this variation, but each individual scribe is internally quite consistent.

5.1.4 Summary: graphic–phonetic correspondences

In Old Norwegian writing, the vast majority of vowels display consistent and unique graphic correspondences. There is a considerable amount of variation in the representation of mid vowels [e, ɛ, o, ɔ] and diphthongs [au, ei, ɛy, øy]. The sources of this variation are in general well understood and do not significantly inhibit the identification of individual vowels or their phonological analysis with respect to vowel harmony and umlaut phenomena.

I have shown that [o, ɔ, a] – <o, a> orthographic variation can be chiefly understood as the result of phonemic–graphemic inventory asymmetries and increased spelling overlap as a result of the neutralising effect of *u*-umlaut. There is no evidence of [o, ɔ] mergers in this corpus. In contrast, there is considerable dialectal variation in /e, ɛ/ contrasts which are undergoing mergers during this period and which significantly contributes to [e, ɛ] – <e, æ> spelling variation. I have demonstrated that the /e, ɛ/ contrast is well-preserved in the vowel harmony manuscript DG8, which serves as a good foundation for examining /e/ vs. /ɛ/ harmony variation in the following sections. Using the harmony manuscript H6, I have demonstrated that non-distinctive [e, ɛ] – <e> orthography is not sufficient evidence to rule out these vowels' contrastivity. A comparative study of **e/*ɛ* harmony patterns in H6 demonstrates both coherent preserved and merging contexts. I have argued this [e, ɛ] – <e> spelling overlap is likely another effect of phonemic–graphemic inventory asymmetries, where long and short vowel graphic inventories are treated separately.

In sum, this study's graphic–phonetic correspondences shows that my phonological annotations based on Holthausen's (1948) reconstructions are accurate and apparent exceptional variation has coherent and well-understood causes in the Old Norwegian orthographic system. Having established that we can accurately identify the set of contrastive phonological and orthographic vocalic units, I now turn to their distribution in various aspects of Old Norwegian phonology with particular focus on their role in vowel height harmony.

5.2 Positional restrictions on the distribution of vowels

To provide a general idea of the frequency of different height classes, I plot the relative proportion of each vowel height by manuscript in Fig. 5.10. This figure shows the distribution of vowel types is quite consistent across scribes, and that the proportion

As outlined in greater detail in the following sections, Old Norwegian vowels are very asymmetrically distributed across stressed/unstressed syllables. Only the peripheral vowels /i, u, a/ regularly occur in all environments. Stressed syllables display maximal contrasts whereas vowel distinctions are very limited in unstressed positions.

5.2.1 Stressed syllables

Monosyllabic words in (88) demonstrate examples of all underlying vowel contrasts in Old Norwegian in stressed positions, taken from DG8. Old Norwegian features lexical stress, which falls on root-initial positions (e.g. [ˈkonongenom] ‘king’-DAT.SG.-DEF.DAT.M.SG.), prefixes (e.g. [ˈfyrir-gefa] ‘for-give’), and class II (stressed) derivational suffixes (e.g. [ˈvirðu-legr] ‘worth-y’), the latter of which are discussed further in section 5.5.2.⁴

(88) Examples of Old Norwegian vowel contrasts in DG8

/i/	[hirð]	<hirð>	‘king’s men’	/i:/	[fri:ð]	<frið>	‘beautiful’
/y/	[dyrr]	<dyrr>	‘door’	/y:/	[dy:rð]	<dyrð>	‘glory’
/u/	[guð]	<guð>	‘god’	/u:/	[tru:r]	<trur>	‘true’
/e/	[er]	<er>	‘which’	/e:/	[se:r]	<fer>	‘sees’
/ø/	[kømr]	<kømr>	‘comes’	/ø:/	[fø:rð]	<førð>	‘led’
/o/	[borð]	<borð>	‘table’	/o:/	[go:ð]	<goð>	‘good’
/ɛ/	[ferð]	<færð>	‘journey’	/ɔ/	[hɔrð]	<horð>	‘hard’
/a/	[jarl]	<iarl>	‘earl’	/a:/	[sa:r]	<sar>	‘wound’
/æ:/	[mæ:r]	<mær>	‘maid’	/au/	[bauð]	<bauð>	‘bade’
/ei/	[meirr]	<mæir>	‘more’	/ey/	[hæyrt]	<hæyrt>	‘heard’

As summarised by the inventory above in (88), 13th-century Old Norwegian writers display 10 qualitatively distinct monophthongs and a total of 20 contrastive vowels when including both diphthongal and long/short monophthongal contrasts.

5.2.2 Unstressed syllables

As outlined in (89), Old Norwegian unstressed syllables display in general only peripheral /i, u, a/ underlying vowels, which occur in non-root-initial syllables (e.g. [ˈli:til-l] <litill> ‘little’-NOM.M.SG.), inflectional suffixes (e.g. [ˈdy:r-um] <dyrum> ‘animal’-DAT.PL.), and class I (unstressed) derivational suffixes (e.g. [ˈsynd-ug-r] <syndugr> ‘sin-ful’-NOM.SG.). The mid vowels [e, o] are derived in unstressed syllables via vowel height harmony (e.g. /gø:l-ing-um/ → [ˈgø:l-eng-om] <gølengom> ‘fondl-ing’-DAT.PL.), and [ɔ] is commonly derived via *u*-umlaut (e.g. /ˈkast-að-u/ → [ˈkast-ɔð-u] ‘cast’-3.PL.PRET.).

⁴The chief historical sources of evidence for Old Norwegian/Old Norse quantity and prosody are comparative reconstruction and the metrics of medieval poetry, see Kristján Árnason (1980, 2000) for overviews.

(89) Unstressed Old Norwegian vowels

i	u	
e	o	- generally only as the result of height harmony
ɛ	ɔ	- generally in loanwords and as the result of <i>u</i> -umlaut
a		

In a limited set of cases, /e, o, ɛ, ɔ/ may occur underlyingly. In unstressed syllables, non-derived /o/ is found in a number of polysyllabic loanwords (e.g. likely /'postoli/ ['postole] <postole> 'apostle' from Old English *a/postol*). In a similar fashion, non-derived /ɛ/ is found in /'akkəri/ ['akkəri] <Ackæri> 'anchor' from Latin or Old English *ancora/ancor*) and certain historical compounds: for example, *misseri* 'season' < **miss-ja:ri* 'mis-year' (cf. Holthausen 1948, p. 197). Non-derived /e/ is found in many dialects in the encliticised definite article /-en-/ (e.g. /'i:s-en-n/ <isenn> 'ice'-DEF.-ACC.M.SG.). Finally, non-derived /ɔ/ occurs very rarely in unstressed positions, such as the plural form /'hærɔð/ ['hærɔð] <hæroð> 'districts' (cf. singular /'hærað/ <hærað>).⁵ These examples illustrate that non-derived unstressed /e, o, ɛ, ɔ/ vowels do rarely occur but only in non-native lexemes or as the result of unique historical linguistic circumstances such as encliticisation or a combination of non-initial rounding, apocope, and shortening.

5.3 Vowel harmony and harmony decay in the Old Norwegian corpus

Currently little is known about the geographic and diachronic variation in Old Norwegian vowel harmony. Following Hægstad's (1899–1942) pioneering work on Old Norwegian dialects, vowel harmony has traditionally been recognised most prominently in 'central' dialects of Old Norwegian (i.e. Trøndelag, Eastern Norway, and Northwestern Norway) but traces of vowel harmony or decayed harmony remnants have since been evidenced throughout the medieval Norwegian corpus; cf. more critical examinations of previously considered 'non-harmonic' Southwestern material in Pettersen (1989) and Knudsen (1936, pp. 197–99). There was surely greater variation in vowel harmony across the Norwegian dialects than preserved in existing material, but it is now generally assumed that vowel height harmony was at some point a common trait across the Norwegian linguistic area (Seip 1955, pp. 130–31; Hagland 2013, pp. 619–21).

In the end, Old Norwegian vowel height harmony did not last, and it is reported in the philological literature that Old Norwegian lost harmony over the course of the 13th–14th centuries (Flom 1934b, Seip 19550, Hødnebo 19770, Hagland 1978a). Currently, the decay of harmony in Old Norwegian and its historical/geographic variation has not received any thorough linguistic analysis. From the few descriptions that do exist, it seems the process of harmony decay in Old Norwegian was gradual. As characterised by Hødnebo (1977,

⁵This irregular plural has a well-understood but very unique history. *Hærað* is a historical compound, combining *herr* < **harjar* 'host' and *ra:ð* < **ra:ð-a* 'council'. The historical plural **hæra:ð-u* underwent *u*-umlaut, rounding to **herv:ð-u*. During the Proto-Norse Syncopé Period (Kiparsky 2009, Haugen 2012), the word-final **u* was apocopated – **herv:ð* < **herv:ð-u* – and ultimately the second syllable was shortened, after which the compound is no longer transparent in meaning, giving us *herð* < *herv:ð*.

p. 379):

This [vowel harmony] system can be seen from the oldest writings and up to a good ways into the 1300s as a kind of norm. Towards the end of the century, there is a steady decline with ever-increasing exceptions to the rule.⁶

This statistical characterisation raises quite a number of interesting questions. At the intersection between phonology and orthography, it is not clear what phonologically active, decaying, and decayed vowel harmony looks like in medieval orthography. For example, how much inconsistency do vowel harmony speakers in the Middle Ages display in non-normalised orthography, and how do we make sense of potentially inconsistent and/or contradictory data in historical corpora? To answer these questions, we must establish methods of measuring and visualising harmony robustness and decay in written corpora. This is easier said than done. In the analysis of Old Norwegian manuscript material in particular, there are certain philological complications which must be addressed, such as the fact that all of the elicited manuscripts here are copies (non-originals). How do we distinguish between the scribe's native phonology/orthographic system and potential copying influence from the exemplar's orthography?

Traditional philological treatments of these questions have been highly speculative and have not provided much in the way of critical conclusions. For example, as outlined in greater detail below, the *Strengleikar* manuscript (written in two hands – in this thesis labelled DG4_7_h1 and DG4_7_h2) displays considerably inconsistent harmony patterns. For Tveitane (1972, p. 17), this inconsistency indicates that the scribes lacked vowel harmony, and ‘any traces of vowel harmony are...best explained as forms that have slipped through from the originals copied’. Hødnebo (1984) on the other hand interprets the same data as genuine vowel harmony, arguing that a degree of variation is to be expected in non-normalised medieval orthography and that these ‘traces’ of vowel harmony are too prevalent to be relegated to copying influence. When interpreting contradictory data in medieval texts, Hødnebo (1984, p. 170) recommends:

The ranking must be interpreted in this way where the main characteristics in the copied manuscript belong to the scribe's school, other less frequent features which are at odds with the main trends come from the exemplar while purely dialectal, individual elements originate in the scribe's native dialect or the dialect of the exemplar's writer.⁷

It is not clear how one could systematically implement the above heuristics, and Hødnebo (1984, p. 163) admits that we lack technical evidence for discerning the cause of orthographic inconsistency, stating ‘on the whole, explanations of these translation and transcription problems are so divergent and unclearly defined that the last word on this has probably not been said’.⁸ Fundamentally, the problem is that we lack adequate comparative data. To provide as broad a picture as possible, I have therefore included all the currently available lemmatised and morphologically annotated manuscripts in MENOTA in this

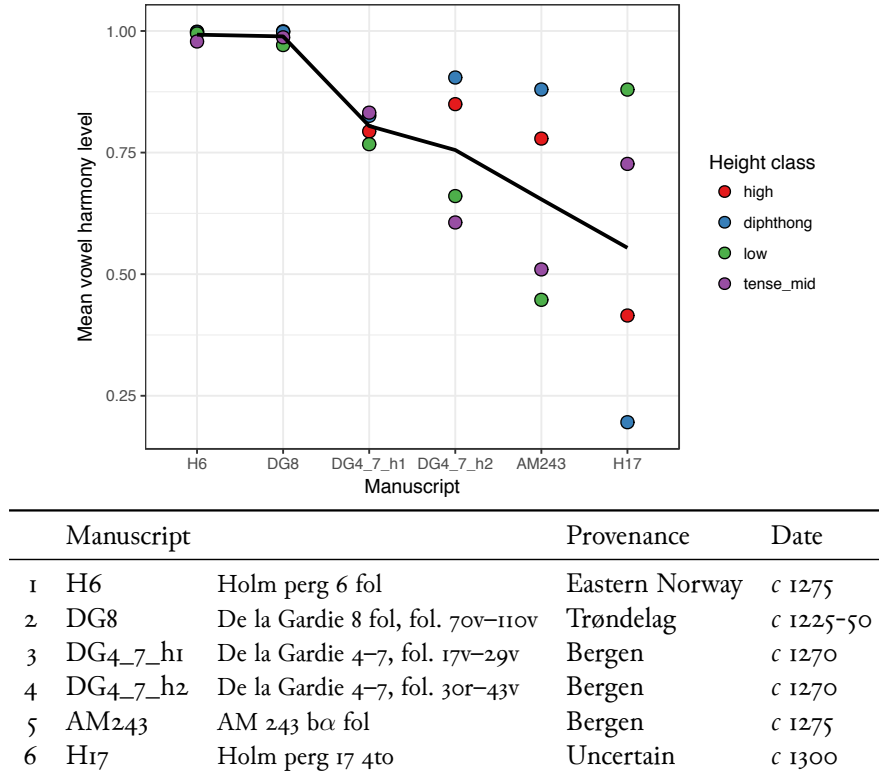
⁶‘Dette systemet kan følges fra eldste skrifttid og et godt stykke inn i 1300-tallet som en slags norm. Henimot slutten av hundreåret inntreier en jevn tilbakegang med stadig flere unntak fra regelen.’

⁷‘Rangeringen må oppfattes slik at hovedtrekkene i det avskrevne håndskrift tilhører skriverens skole, andre mindre frekvente trekk som krysser hovedtendensene, kommer fra forelegget mens rene dialektale enkeltinnslag stammer fra skriverens hjemlige målføre eller målføret til foreleggets skriver.’

⁸‘I det hele er forklaringene på oversetter- og overleveringsproblemene hittil så pass sprikende og uklart definert at siste ord om dette nok ikke er sagt.’

study's corpus, regardless of the presence or lack of clear harmony patterns. This collection of manuscripts with considerable variation in harmony consistency and robustness allows us to quantify, visualise, and examine a broad range of variation in vowel co-occurrence, on which we can begin to define some relative criteria for establishing pre-, transitional, and post-harmony decay stages of the language.

Figure 5.12: Mean harmony levels by manuscript height class in pairwise sequences



A preliminary look at height harmony frequencies in pairwise vowel sequences by V_1 -height classes across this corpus' manuscripts is provided in Fig. 5.12. Here I plot the percentage of harmony in potentially harmonising contexts – that is, initial vowel sequences in non-compound words consisting of harmonic V_1 -height classes (i.e. diphthongs, high, tense mid, or low vowels) and potentially alternating V_2 vowels (i.e. [i, e, u, o]). A reference line is added depicting each manuscript's harmony mean in potentially harmonising contexts. This figure visualises the spectrum of harmony level and dispersion across height classes present in the corpus, but note that the manuscripts are ordered by their mean vowel harmony level (from high to low) – not by their estimated provenance or date of writing. On the basis of this limited corpus, we cannot make any concrete claims about the geography or chronology of harmony decay. Nevertheless, Fig. 5.12 evidences a number of important generalisations.

First, lower mean vowel harmony is correlated with increasing dispersion, demonstrating that harmony decay is present in the corpus. The manuscripts on the left (H6 and DG8) illustrate robust harmony systems, where height correspondence is under tight control (high harmony and low variance). The DG4_7 scribes display two variants of transitional systems; DG4_7_h1 demonstrates lower harmony but still low variance, and while the second hand DG4_7_h2 features greater dispersion, all height classes (both

high and non-high vowels) still display height correspondence well above the threshold of 50%. In other words, even though there is considerable variation across height classes in DG4_7_h2, all height classes still display a considerable statistical tendency towards height harmony. Finally, the manuscripts on the right have lost harmony (low harmony and high variance).

The plot in Fig. 5.12 also reveals coherent sub-groupings in the decaying or decayed manuscripts (DG4_7_h2, AM243, H17). In these three manuscripts, high/non-high height classes pattern systematically together. In particular, in DG4_7_h2 and AM243, we find greater high/diphthong ‘harmony’, suggesting the loss of harmony gives way to a generalisation towards non-alternating high inflectional vowels [-i, -u] for these scribes (e.g. like Modern Icelandic which has fixed high-vowel inflectional vowels *húsi* ‘house’-DAT.SG. vs. *ljósi* ‘light’-DAT.SG.). This results in more frequent high V_2 vowels – producing greater ‘harmonic’ co-occurrence between high vowels and less between non-high vowels. In H17 we find the opposite pattern, with greater non-high (mid/low) ‘harmony’ – indicating a general levelling towards non-high [-e, -o] suffixes – similar to fossilised dative inflections in Eastern Norwegian *buse* ‘house’ vs. *dale* ‘valley’. The manuscripts thus display coherent directions of change towards outcomes known from modern Nordic languages.

An alternative way of visualising the spectrum of harmony decay in the corpus is provided in Fig. 5.13 using *PhonMatrix* visualisations, developed by Mayer, Rohrdantz, et al. (2010) and Mayer & Rohrdantz (2013) – accessible at <http://phonmatrix.herokuapp.com/>. These visualisations take as an input a V_1 - V_2 vowel matrix where each vowel pair is assigned some association measure based on their frequency of occurrence. In this case, I have used phi coefficient scores, a normalised measure of association based on the χ^2 coefficient.⁹ The phi coefficient ranges from -1 to 1, and the *PhonMatrix* visualisation maps the phi values to a bipolar colour scale (from red to blue); the darkness of the colour provides a visual indicator of the strength of each V_1 - V_2 association – positive associations are blue, and negative associations are red (see Mayer & Rohrdantz 2013 for details). The *PhonMatrix* platform currently requires each segment to be monographic (i.e. *a:* and *au* are currently not permitted). Diphthongs are therefore not considered in Fig. 5.13, and long vowels are represented with acute accents ($\acute{y}=\acute{y}$). Short [ø] occurs too infrequently to provide reliable results and is therefore not included.

For clarity’s sake, I have added reference lines to Fig. 5.13, dividing high and non-high vowels. As shown here, in pre-harmony decay manuscripts (H6/DG8), V_2 -[e, o] vowels (the *e/o* columns) strongly correlate with non-high vowels [a, á, æ, ø, é, ó, e, o] as indicated by the blue [+] cells, representing positive phi values. The reverse pattern is demonstrated by V_2 -[i, u] vowels (the *i/u* columns), which pattern with high V_1 -vowels

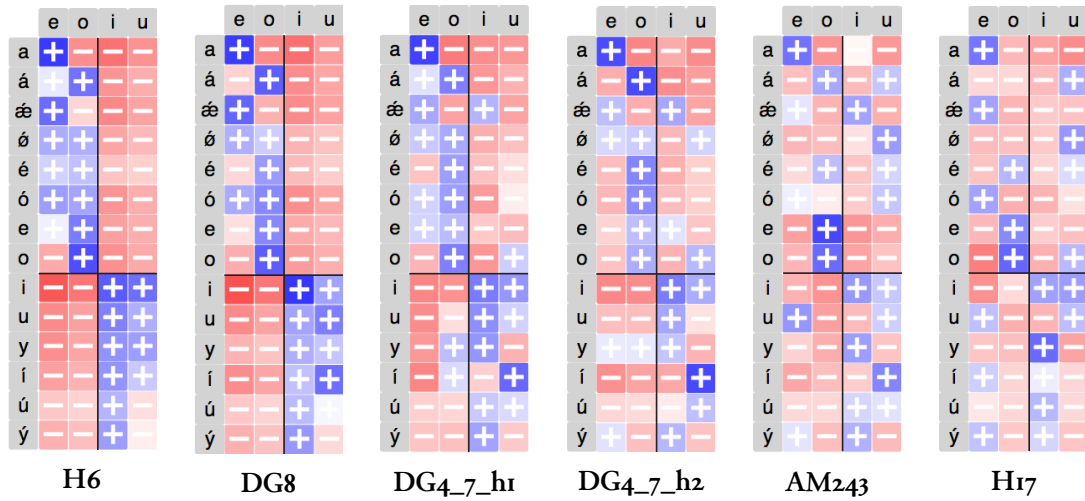
⁹The phi coefficient is defined as the square root of the ratio of χ^2 to the sample size (i.e. $\phi = \sqrt{\frac{\chi^2}{n}}$). To illustrate the way in which it is calculated, let us assume the V_1 -[a] and V_2 -[e] vowel matrix below in (ii) with co-occurrence values *v*, *x*, *y*, and *z* and row/column totals *a*, *b*, *c*, *d*. For these two vowels, the formula for the phi coefficient would be: $\phi = \frac{v \cdot z - x \cdot y}{\sqrt{a \cdot b \cdot c \cdot d}}$

(ii) [a...e] contingency table

	[e]	not-e	Total
[a]	v	x	a
not-a	y	z	b
Total	c	d	

[i, u, y, í, ú, ý] – resulting in the stark asymmetric distribution of blue/red [+]/[–] cells between high/non-high vowels. From left to right, this pattern is less and less discernable as the effect of harmony decay increases to completion in AM243/H17.

Figure 5.13: *PhonMatrix* visualisations of 13th-century Old Norwegian harmony decay



The Old Norwegian corpus which demonstrates pre-, transitional, and post-harmony decay stages is cross-linguistically very unique. The loss of vowel harmony is indirectly known to have occurred in a variety of languages from diachronic and/or cross-dialectal correspondences with historical or existing harmony languages. For example, in comparison to harmonic Turkish, the related non-literary South Eastern Turkic language Uzbek lacks harmony (Sjoberg 1963), but the process of harmony decay in action has never been directly documented in any contemporary language or historical record. How vowel harmony decay occurs and what factors motivate this rare development are accordingly very unclear since the historical stages during which these changes took place are not documented. There is a crucial missing link in the typological record, which the Old Norwegian corpus can fill: the transition from a harmonic to non-harmonic language.

Comparisons between harmonic/non-harmonic dialects (Kavitskaya 2013), diachronic comparisons before and following harmony decay (McCollum 2015, Bobaljik 2018), and/or agent-based computational modelling of potential trajectories of vowel harmony evolution/dissolution (Harrison, Dras & Kapicioglu 2006; Mailhot 2010) suggest that changes in vowel inventories (mergers/splits), emergence of disharmonic morphemes, and language contact (i.e. via the influx of disharmonic foreign loanwords) likely play important roles in motivating harmony decay, but we have previously lacked much empirical evidence with which to evaluate how and why these factors might converge on the loss of harmony and crucially how such phonological changes occur across generations. We have currently still too little data to provide much insights on these matters, but the vowel harmony distributions in Figs. 5.12/5.13 demonstrate that the Old Norwegian corpus has very valuable evidence bearing on these questions. I leave for future work a more detailed analysis of the process of harmony decay in Old Norwegian once more material has been digitised.

For our present purposes, however, there are a number of important conclusions we can make. 1) Robust harmony systems admit very few exceptions in writing, even in non-

normalised, medieval orthography. This is evidenced by the two manuscripts DG8/H6, which in harmonising contexts apply harmony basically at ceiling – demonstrating near 100% harmony across harmonic height classes. 2) The less robust harmony manuscripts provide important insights into how gradient harmony systems may or may not be, and whether there are distinct intermediate stages in the harmony decay process (cf. Kavitskaya 2013). As shown in Fig. 5.12, the scribe DG4_7_h1 clearly illustrates a good candidate for a transitional harmony system, where harmony levels are quite uniform (i.e. phonologically regulated) but are significantly lower than the robust harmony systems in DG8/H6. And 3) the data in Figs. 5.12/5.13 illustrate that manuscripts with high variance across height classes (i.e. post-harmony decay manuscripts) may still retain considerable residual remnants of the harmony distributions, consistent with modern potentially transitional or decayed harmony systems which display remnant harmony-like phonetic co-articulatory patterns (cf. McCollum 2015). This is a potential example of ‘rule scattering’, wherein phonetic height co-articulation may persist long after phonological harmony ceases to be (cf. Bermúdez-Otero 2007, 2015). This kind of pattern is particularly clear in DG4_7_h2, where the majority of vowels still display relatively high mean harmony levels in historically harmonising contexts – ranging from 71.0% to 90.5% among low/high vowels and diphthongs (see Fig. 5.12).

In sum, a broad examination of vowel harmony patterns across a range of manuscripts suggest Old Norwegian orthography provides coherent and high-quality data with significant implications for the cross-linguistic study of vowel harmony decay. This survey has demonstrated distinct pre-, transitional, and post-harmony decay stages in 13th-century Old Norwegian manuscripts, which display coherent directions of change towards non-harmonic phonologies known in modern Nordic languages. Finally, the harmony manuscripts DG8/H6 illustrate that robust harmony systems are represented categorically, even in non-normalised medieval orthography – providing reliable phonological data for a detailed study of Old Norwegian height harmony.

5.4 Old Norwegian harmony descriptive generalisations

Building on the insights presented in the previous sections regarding Old Norwegian vowels and their distribution, orthography, and broader phonological patterns, I provide below a concise presentation of the major features of Old Norwegian vowel height harmony in pre-harmony decay manuscripts DG8/H6. Old Norwegian vowel height harmony displays the following characteristic properties:

(90) Old Norwegian height harmony characteristics

(a) *Harmonic lowering*

- High vowels harmonise to non-high vowels
- Underlying non-high vowels do not harmonise to high vowels

(b) *Non-parasitic*:

- Labial vowels harmonise to non-labial vowels and vice versa
- No labial/non-labial asymmetry in harmonising segments

(c) *Inventory asymmetries and harmony neutrality:*

- / ϵ , ɔ / are neutral blockers
 - **non-alternating**: no [ϵ , ɔ] * [ɪ , ʊ] harmony alternations
 - **neutral**: do not trigger vowel lowering
 - **visible**: harmony cannot spread past underlying non-initial / ϵ , ɔ / vowels
- / æ ː, a , a ː/ are harmonic blockers
 - **non-alternating**: no low/non-low alternations
 - **harmonic**: trigger vowel lowering
 - **visible**: no harmony spreading across non-initial low vowels

(d) *Prosodic conditioning:*

- Harmony is blocked by stressed syllables

Concisely put, Old Norwegian displays prosodically sensitive, non-parasitic vowel height harmony via vowel lowering with multiple classes of neutral (non-alternating) segments [ϵ , ɔ] and [æ , æ ː, a , a ː], which display neutral and harmonic blocking, respectively. All of the characteristics of Old Norwegian vowel harmony outlined above are known independently in other height harmony systems (see in particular surveys of Bantu height harmony by Hyman 1999 and Odden 2015), but the unique combination of non-parasitism with both harmonic and neutral blocking is not otherwise attested in vowel height harmony. Old Norwegian is thus both typologically consistent and cross-linguistically unique among other height harmony languages. In the following sections, I provide concise characterisations of DG8/H6 harmony patterns.

5.4.1 Height harmony via vowel lowering

All qualitatively distinct harmonising (alternating) vowels are illustrated in disyllables with both nominal and verbal inflections in (91). Here I provide examples using dative singular/plural and 3. person singular/plural preterite suffixes. Vowel length, though contrastive, plays no role in the harmony patterns. Note that the dental consonant of the preterite suffix assimilates to preceding consonants. For clarity's sake, harmony triggers are marked by underlining.

(91) **Height harmonic alternations in inflectional suffixes**

a.	'skip-i	<fkipi>	'skip-um	<fkipum>	'ship'-DAT.SG./PL.
b.	'dy:r-i	<dyri>	'dy:r-um	<dyrum>	'animal'-DAT.SG./PL.
c.	'hu:s-i	<hufi>	'hu:s-um	<hufum>	'house'-DAT.SG./PL.
d.	'veg-e	<vege>	'veg-om	<vegom>	'way'-DAT.SG./PL.
e.	'dø:m-e	<døme>	'dø:m-om	<dømom>	'example'-DAT.SG./PL.
f.	'dø:m-e	<døme>	'dø:m-om	<domom>	'judgement'-DAT.SG./PL.
g.	'birt-ti	<birtti>	'birt-tu	<birttu>	'illuminate'-3.PRET.SG./PL.
h.	'fylg-ði	<fylgði>	'fylg-ðu	<fylgðu>	'follow'-3.PRET.SG./PL.
i.	'θurp-ti	<þurpti>	'θurp-tu	<þurpttu>	'need'-3.PRET.SG./PL.
j.	'ger-ðe	<gerðe>	'ger-ðo	<gerðo>	'do'-3.PRET.SG./PL.
k.	'fø:d-de	<fødde>	'fø:d-do	<føddo>	'birth'-3.PRET.SG./PL.
l.	'θol-de	<þollde>	'θol-do	<þolldo>	'tolerate'-3.PRET.SG./PL.

The vowels [y, ø] do not display harmony alternations but do share a number of synchronic phonological properties which suggest that they are paired for the harmony feature. For example, /y(:), ø(:)/ appear to be paired harmony triggers in stressed positions – e.g. triggering high ['dy:r-um] vs. non-high harmony ['dø:m-om] in (91) – and are matched with other harmony-pairs /u(:), o(:)/ in palatalising *j*-umlaut: e.g. Seip (1955, pp. 123, 247) provides the examples ['sjy:k,leikr] <siykleikr> 'sickness'-NOM.SG. for earlier non-palatalised **sju:k-leikr* found in the Norwegian manuscript fragment NRA 81 B (c 1200) and ['ljø:pu] <liøpu> for older **ljø:pu* 'run'-PRET.3.PL. in the Icelandic manuscript AM 122 a fol. (c 1350–70). These facts suggest that the vowels /y, ø/ should be height-paired harmony alternates in target positions, but there are no data by which this assumption could be tested since these vowels for etymological reasons do not occur underlyingly in unstressed (non-initial) positions in which they could undergo harmony. Thus, the observed patterns suggest [y]/[ø] alternations are in theory possible but never occur in practice.

5.4.2 **Neutral blocking lax mid vowels**

Old Norwegian displays one class of inactive non-high vowels /ε, ɔ/, variably represented in writing as <æ, e> and <o, a>. See sections 5.1.1/5.1.2 for detailed explorations of these vowels' orthography and phonology. /ε, ɔ/ fail to initiate vowel lowering, as shown below in (92).

(92) **Neutral /ε, ɔ/ vowels in root-initial positions**

a.	'hεll-i	<hælli>	'hεll-um	<hellum>	'cave'-DAT.SG./PL.
b.	'fjɔtr-i	<fiotri>	'fjɔtr-um	<fiotrum>	'fetter'-DAT.SG./PL.
c.	'sεt-ti	<fætti>	'sεt-tu	<fættu>	'set'-PRET.3.SG./PL.
d.	'stɔðv-it	<ftoðvit>	'stɔðv-ɔð-u	<ftoðpaðu>	'stop'-PRET.PART./PRET.3.PL.

For historical reasons, lax mid /ε, ɔ/ vowels only rarely occur non-initially (in target positions). During the Proto-Norse Syncope Period, short vowels were elided in unstressed positions, so the few examples of non-initial [ε] and [ɔ] found in post-syncope Old Norwegian are the result of rather unique historical sound changes, loanwords, or derived via synchronic *u*-umlaut (Kiparsky 2009, Haugen 2012). The few contexts in

which non-initial [ɛ, ɔ] do occur show that /ɛ, ɔ/ are neutral blocker vowels – non-transparently halting harmony from applying at long distances.

(93) **Non-initial [ɛ, ɔ] vowels are neutral blockers**

- | | | | | |
|----|-------------|--------------|------------|--------------------------------------|
| a. | 'akker-i | *'akker-e | <Akcæri> | 'anchor'-ACC.SG |
| b. | 'θjo:nɔst-u | *'θjo:nɔst-o | <þionastu> | 'service'-ACC.SG. |
| c. | 'hɛrɔð-um | *'hɛrɔð-om | <hæroðum> | 'district'-DAT.PL. |
| d. | 'blo:t-ɔð-u | *'blo:t-ɔð-o | <blotaðu> | 'worship with sacrifice'-PRET.-3.PL. |
| e. | 'stɔðv-ɔð-u | *'stɔðv-ɔð-o | <ftoðpaðu> | 'stop'-PRET.-3.PL. |
| f. | 'ɛggj-ɔð-u | *'ɛggj-ɔð-o | <æggiðu> | 'egg on'-PRET.-3.PL. |

As illustrated above in (93), in non-initial positions [ɛ, ɔ] vowels are non-alternating and are neutral blockers. In other words, lax mid vowels are visible insofar as they block harmony spreading – i.e. displaying non-transparency in ['blo:t-ɔð-u], not *['blo:t-ɔð-o] – and lax mid vowels are inactive or inert since they trigger no harmony alternations. Neutral segments like [ɛ, ɔ] which are both non-alternating and non-triggering are an indicator of the underlying value of harmony targets, which in the case of Old Norwegian – like 'canonical' Bantu height harmony – are high vowels. This reveals that the active harmony feature is some lowering-[open] feature in Old Norwegian; see section 6.2.1 for a more detailed analysis of the Old Norwegian harmony feature.

5.4.3 Harmonic blocking low vowels

Lax mid /ɛ, ɔ/ and low /æ:, a, a:/ vowels display crucially differing harmony patterns. In stressed positions, low vowels are harmonic triggers and take non-high suffixes (94). The class of harmony triggers thus includes both mid vowels /e, e:, ø, ø:, o, o:/ and low vowels /æ:, a, a:/. Old Norwegian is thus similar to Mbunda (K.15) or Pende (L.11/K.52), previously discussed in section 1.2.2, which display harmonic mid and low vowels (Gowlett 1970; Niyonkuru 1978; Hyman 1999, pp. 242–43).

(94) **Harmonic lowering following low vowels**

- | | | | | | |
|----|-----------|----------|-----------|----------|----------------------------|
| a. | 'hæ:tt-e | <hætte> | 'ha:tt-om | <hattom> | 'mode of life'-DAT.SG./PL. |
| b. | 'ma:l-e | <male> | 'ma:l-om | <malom> | 'matter'-DAT.SG./PL. |
| c. | 'gʲæ:t-te | <giætte> | 'gʲæ:t-to | <giætto> | 'watch'-3.PRET.SG./PL. |
| d. | 'ma:t-te | <matte> | 'ma:t-to | <matto> | 'be able'-3.PRET.SG./PL. |

The only low vowel found underlyingly in non-initial positions in Old Norwegian is short /a/, and its patterns in unstressed (target) positions are consistent with its behaviour in stressed (trigger) syllables. Low vowels are non-alternating and are harmonic blockers, as shown in (95). In other words, low vowels are neutral insofar as they do not display harmony alternations in target positions but harmonic (active and visible) insofar as they trigger vowel lowering on following vowels, regardless of preceding vowels. Unstressed low vowels therefore result in word-medial disharmony following high vowel roots: e.g. ['vi:s-að-e], not *['vi:s-að-i].

(95) **Harmonic blocking low vowels**

a.	'vi:s-að-e	<viðaðe>	'shew'-3.SG.PRET.
b.	'fu:n-að-e	<funaðe>	'rot'-3.SG.PRET.
c.	'svi:kar-e	<fuikare>	'traitor'-NOM.SG.
d.	'huggar-e	<huggare>	'comforter'-NOM.SG.
e.	'riddar-a-nom	<riddaranom>	'knight'DAT.SG.-DEF.
f.	'hǫfðingj-a-nom	<hofðingianom>	'chieftain'-DAT.SG.-DEF.

As this survey illustrates, Old Norwegian displays Mbunda-like harmonic low vowels which are both visible and active with respect to the harmony feature. Like Ndendeule (N.101), discussed in sections 1.2.2/2.4.1, Old Norwegian features two classes of harmonically unpaired (non-alternating) vowels. However, where Ndendeule has harmonic /ε, ɔ/ and neutral /a/, Old Norwegian has harmonic /a/ and neutral /ε, ɔ/.

5.4.4 **Inert diphthongs**

Old Norwegian displays three falling diphthongs which I have interpreted as /au, ei, ey/ in DG8 and /au, ei, øy/ in H6. Old Norwegian diphthongs only occur in stressed syllables in which they pattern like high /i, y, u/ or neutral /ε, ɔ/ vowels – taking high vowel suffixes (96). Old Norwegian diphthongs thus do not trigger harmony, and the second vocalic element does not undergo vowel harmony; that is, a fully [open] diphthong such as [ao] is not allowed: e.g. ['dauð-ir], not *['daoð-er].

(96) **No harmony following diphthongs**

a.	'dauð-ir	<dauðir>	'dauð-um	<dauðum>	'dead'-M.NOM.PL./DAT.PL.
b.	'heiðrn-ir	<hæiðrnir>	'heiðrn-um	<hæiðrnum>	'heathen'-M.NOM.PL./DAT.PL.
c.	'brøysk-ir	<brøyskir>	'brøysk-um	<brøyskum>	'brittle'-M.NOM.PL./DAT.PL.
d.	'rei:s-ti	<ræisti>	'rei:s-tu	<ræistu>	'raise'-3.PRET.SG./PL.
e.	'leys-ti	<læysti>	'leys-tu	<læystu>	'loosen'-3.PRET.SG./PL.
f.	'gløym-di	<gløymdi>	'gløym-du	<gløymdu>	'forget'-3.PRET.SG./PL.

In section 6.3.3, I show how these representational/harmony generalisations may be construed as head-dependent asymmetries (Dresher & van der Hulst 1998). While the diphthongs' nuclear-element may display mid, lax, and low vowels (i.e. [ø, ε, a]), the non-nuclear element of diphthongs only display less-marked high vowel contrasts (i.e. [i, y, u]) – suggesting a phonotactic restriction against more marked structure in non-nuclear positions.

5.5 **Prosodic limitations**

Like other Germanic languages, Old Norwegian had lexical stress, and Old Norwegian vowel harmony is stress-dependent (cf. Majors (1998, 2006) for overviews of stress-dependent harmony systems). Old Norwegian vowel harmony operates from stressed to unstressed syllables and is blocked by stressed positions, as evidenced by stressed derivational suffixes, prefixes, and compounds.

5.5.1 Non-simplex words

Vowels in primary or secondary stressed positions in Old Norwegian are invariably non-alternating. In (97), I provide examples of prefixed, compound, and simplex words (of Latin origin) which display combinations of primary and secondary stressed syllables.

(97) No harmony across root-boundaries

a.	'mīs-,mūn-r	<mismunr>	'difference (=dis-object)'-NOM.SG.
b.	'mīs-,mæ:l-e	<mismæle>	'slip of the tongue (=mis-speaking)'-NOM.SG.
c.	'ēndr-,ny:-a-st	<endrnyast>	're-new'-PRES.3.SG.-REFLEX.
d.	'ēndr-,rø:r-a-st	<endrørast>	'move again'-PRES.3.PL.-REFLEX.
e.	'firir-,bu-it	<firirbuit>	'prepare'-PRET.PART.
f.	'firir-,boð-et	<firirboðet>	'forbid'-PRET.PART.
g.	'o:-,ti:m-i	<otimi>	'the wrong time (=un+time)'-NOM.SG.
h.	'o:-,θokk-e	<oþokce>	'disgust (=un+thought)'-NOM.SG.
i.	'hirð#,menn	<hirðmenn>	'king's men'-NOM.PL.
j.	'li:til#,læ:t-i	<litilæte>	'humility (=small+manner)'-NOM.SG.
k.	'sto:r#,lut-um	<storllutum>	'big piece'-DAT.PL.
l.	'na:t,tu:r-um	<natturum>	'nature'-DAT.PL.

The harmony mechanism in Old Norwegian only applies to unstressed positions. Harmony therefore never occurs across root boundaries in prefixed or compound words since root-initial vowels are inherently stressed (97): e.g. ['sto:r-,lut-um], not *['sto:r-,lot-om] and ['o:-,ti:mi], not *['o:-,te:me]. Short vowel prefixes never undergo harmony: e.g. ['mis-,mæ:l-e], not *['mes-,mæ:l-e]. And certain Latin loans display multiple stressed syllables, which also fail to undergo harmony: e.g. ['na:t,tu:r-um], not *['na:t,to:r-om] (from Latin *nātūra*; cf. Icelandic *náttúra*).

5.5.2 Derivational suffixes

There are two classes of derivational suffixes evident in the corpus; class I suffixes – those that harmonise, such as the substantivising /-(n/l)ing-/ and adjectivising /-ug-/ suffixes in (98a–d) – and class II suffixes, which do not harmonise, such as the adjectivising /-leg-/ and the substantivising /-ynd-/ suffixes in (98e–h).¹⁰

(98) Harmonising and non-harmonising derivational suffixes

a.	/sy:t-ing-um/	['sy:t-ing-um]	<fytingum>	'wailing' (wail+SUBS.)-DAT.PL.
b.	/'gø:l-ing-um/	['gø:l-eng-om]	<gølengom>	'fondling' (soothe+SUBS.)-DAT.PL.
c.	/'synd-ug-um/	['synd-ug-um]	<fyndugum>	'sinful' (sin+ADJ.)-DAT.M.PL.
d.	/'ma:tt-ug-um/	['ma:tt-og-om]	<mattogom>	'mighty' (might+ADJ.)-DAT.M.PL.
e.	/'re:tt-ynd-um/	['re:tt-ynd-um]	<rettyndum>	'justice' (just+SUBS.)-DAT.PL.
f.	/'sann-ynd-um/	['sann-ynd-um]	<fannyndum>	'truth' (true+SUBS.)-DAT.PL.
g.	/'dy:r-,leg-u/	['dy:r-,leg-o]	<dyrlego>	'glorious' (glory+ADJ.)-DAT.N.SG.
h.	/'virði-,leg-u/	['virði-,leg-o]	<pirðilego>	'worthy' (worth+ADJ.)-DAT.N.SG.

¹⁰Here there is slight variation between DG8 and H6 with respect to /-(n/l)ing/ which is consistently harmonic in H6 but not in DG8. This suffix appears therefore to belong to class I in H6 but to class II in DG8.

Here Modern Icelandic provides some essential comparative evidence to help us explain these blocking patterns. Modern Icelandic also displays two classes of derivational suffixes with a similar dichotomy in phonological patterning. As shown in (99), the affixation of weak or class I suffixes in Icelandic may trigger vowel shortening–preaspiration or the occlusion of [ɣ] before /n/ or /l/ (Kristján Árnason 1987, 2005, 2011). Class II suffixes and compound elements on the other hand do not trigger these processes: e.g. ['sju:k,leɣ-yr̥] and ['haɣ,ni:ta], not *['sjuhk,leɣ-yr̥] and *['hak-,ni:ta]. The key point is that though we are dealing with different phonological processes, etymologically related derivational suffixes display the same class division based on stress in both Old Norwegian and Modern Icelandic. Class I suffixes trigger shortening–preaspiration and occlusion in Icelandic and undergo height harmony in Old Norwegian. Class II suffixes trigger none of these processes in Icelandic and fail to undergo height harmony in Old Norwegian. For a list of both suffix types, see Kristján Árnason (2005, p. 303).

(99) **Derivational suffixes and preaspiration, shortening, and occlusion in Icelandic** (Kristján Árnason 2011, pp. 259–62)

Class I	<i>sjúk-lingur</i>	['sjuhk-lɪŋk-yr̥]	‘patient’
	<i>hag-naður</i>	['hak-nað-yr̥]	‘profit’
Class II	<i>sjúk-legur</i>	['sju:k,leɣ-yr̥]	‘sickly’
	<i>hag-legur</i>	['haɣ,leɣ-yr̥]	‘well made, handy’
Compounds	<i>út#nes</i>	['u:t-,nɛs]	‘peninsula’ (out+headland)
	<i>hag#nýta</i>	['haɣ-,ni:ta]	‘utilise’ (handy+use)

Class II derivational suffixes were historically compounds (e.g. /-,leg-/ < Proto-Norse *-li:kaR “body, corpse”), and it is therefore not surprising that they retain secondary stress. Given that vowel harmony is generalised over unstressed syllables in Old Norwegian, vowels in these suffixes are non-needy. In other words, stressed derivational suffixes behave in the same way as second components in compounds (97) and do not display any alternations – e.g. ['re:tt-,ynd-um], not *['re:tt-,ønd-om] – and non-high suffixes are specified [open] and therefore trigger vowel lowering in following inflectional suffixes: ['dy:r-,leg-o], not *['dy:r-,leg-u]. In sum, vowel harmony patterns in relation to derivational suffixes are easily understood as an aggregate effect of prosodic limitations on the harmony process and intervening feature under/specification – [open]-suffixes like /-,leg-/ trigger harmonic lowering while [open]-non-specified suffixes such as /-,ynd-/ do not.

5.6 Harmony interactions with other sound patterns

Old Norwegian height harmony interacts with a number of other kinds of vocalic assimilations; namely, so-called *j*-umlaut which palatalises an immediately following back vowel (chiefly /ja/ → [jæ]), *i*-umlaut which involves the palatalisation of back vowels before a following /i/ in morphologically specific environments, and *u*-umlaut which represents a form of long-distance rounding of /a/ → [ɔ] before a following /u/. I provide examples of each type in (100).

(100) **Overlapping height harmony and *j*-, *i*-, and *u*-umlaut**

a.	/ʃjarri/	→	[ʃjærr̥e]	<fiærre, fiarre>	‘far off’ ADV.
b.	/gjaf-ir/	→	[ʃjæv-er]	<giæver, giaver>	‘gift’-ACC.PL.
c.	/haf-ir/	→	[hæv-ir]	<hævir, hevir>	‘have’-PRES.3.SG.INDIC.
d.	/gang-it/	→	[gæŋg-it]	<gængit, gengit>	‘walk’-PRET.PART.
e.	/barn-um/	→	[børn-um]	<barnum, bornum>	‘child’-DAT.PL.
f.	/land-um/	→	[lɔnd-um]	<landum, londum>	‘land’-DAT.PL.

The status of each of these processes has not previously been established, and each are discussed in detail in section 6.4. As illustrated in (100), each umlaut is variably represented in Old Norwegian orthography, but for varying reasons. My detailed grapho-phonological analyses in sections 5.1.1/5.1.2 show that variable *u*- and *i*-umlaut spelling patterns are chiefly simply orthographic – products of asymmetries between Old Norwegian sound and letter inventories (i.e. [e, ɛ, æ]–<e, æ> and [o, ɔ, a]–<o, a>), where the umlaut-product vowels [ɛ, ɔ] have no unique spelling. Once we control for orthographic factors, the data suggest that *i*- and *u*-umlaut are phonetically categorical despite their variable written representation.

The case of *j*-umlaut introduces a novel type with variation between front and back <æ, a> in (100ab), which seems to indicate genuine variability in phonological application. When it does occur, it interacts transparently with height harmony in contrast to *i*- or *u*-umlaut which bleed height harmony: e.g. a underlying form such as /ʃjarri/ is both palatalised and height harmonised to [ʃjærr̥e] while /haf-ir/ is palatalised but height disharmonic (i.e. [hævir]). Traditionally in historical Norse phonology, the low product of palatalisation via *j*-umlaut and that of *i*-umlaut have not been distinguished and are generally assumed to be identical (cf. Seip 1955, pp. 119–23). I posit the products of these palatalisations are featurally distinct, and this is confirmed by their distinct orthographic and phonological patterns.

Where it occurs, the result of *j*-umlaut is always spelled <æ> and is always height harmonic in both DG8/H6 manuscripts (100ab) – orthographically and phonologically like its long counterpart [æ:]–<æ> (e.g. [fæ:r-re] <færre> ‘few’-COMP.). This suggests therefore that *j*-umlaut palatalises /a/ to [æ]. In comparison, palatalised /a/ in *i*-umlaut contexts displays variable <æ, e> spellings in DG8, is nearly exclusively represented as <e> in H6, and is categorically harmonically neutral (100cd). The product of *i*-umlaut is thus consistent with a lax, mid vowel [ɛ] (cf. [ɛ]-orthographic and harmony patterns in section 5.1.2). *I*-umlaut is categorical and non-optional; that is, there is no *i*-umlauted/non-umlauted <hævir>/*<haver> variation like *j*-umlaut. Finally, height harmony and *i*-umlaut interact non-transparently with *i*-umlaut bleeding height harmony. These orthographic and phonological patterns are summarised in (101) taken from the H6 manuscript, which displays phonological and orthographic near minimal pairs – writing disharmonic [ɛ] as <e> and harmonic [æ] as <æ>.

(101) **Distinct *j*- and historical *i*-umlaut product vowels**

a.	/gjaf-ir/	→	[ʃjæv̥er]	<giæver>	‘gift’-ACC.PL.
b.	/haf-ir/	→	[hæv̥ir]	<hevir>	‘have’-PRES.3.SG.INDIC.
c.	/tjald-at/	→	[tjældat]	<tiælldat>	‘tent’-PRET.PART.
d.	/tal-d-i/	→	[tældi]	<teldi>	‘count’-PRET.-3.SG.SUBJ.

U-umlaut like *i*-umlaut interacts non-transparently with height harmony (100ef). In forms such as /'barn-um/, *u*-umlaut and height harmony are in theory potentially overlapping since /a/ is a lowering harmony trigger while unstressed /u/ is a *u*-umlaut trigger. In these contexts, *u*-umlaut like *i*-umlaut bleeds height harmony: e.g. umlauted but height disharmonic ['børnum], not *['børnom]. The nature and status of *u*-umlaut is considerably more contested in Nordic linguistics than other forms of umlaut. I treat these processes and their implications for height harmony in much greater detail in section 6.4.

5.7 Definite enclitic (non-)exceptional patterns

5.7.1 Form and function

One of the more exceptional harmony patterns in Old Norwegian is displayed by the encliticised definite article. Historically the factors which govern definite suffix harmony patterns have been poorly understood, and it has been generally assumed that definite suffixes are exceptionally non-harmonic in Old Norwegian (cf. Halvorsen 1989, p. 110; Hagland 1978b, p. 90). But as outlined in this section, the exceptional behaviour of definite enclitics in Old Norwegian is systematic and can be by and large understood as the intricate mixture of dialectal variation, interaction with orthogonal vowel deletions, and *u*-umlaut.

Like German, the definite article in Old Norwegian inflects for case, gender, and number in correspondence with the noun it modifies and comes in two variants with a high and non-high vowel, depending on the writer/dialect: (*h*)*in*- or *en*- (here uninflected). The article occurs independently in modified environments such as in <hinum gamla kononge> 'the old king'-DAT.SG. in (102ac), but it is otherwise most often encliticised as in (102bd): e.g. <með konongenom> 'with the king' (Nygaard 1905, Faarlund 2004).

- (102) a. DG8 fol. 7r18: <milli þessa ens mikla liðs>

milli þess-a en-s mikl-a lið-s
among this-GEN.N.SG. the-GEN.N.SG. great-GEN.N.SG. host-GEN.SG.
'among this great host'

- b. DG8 30r19–20: <sa-man dratt liðsens>

samandratt lið-s-en-s
gathering-ACC.SG. host-GEN.SG.-DEF.-GEN.N.SG.
'gathering of the host'

- c. **H6 fol. 89v7a:** <kennddi. feðr fínun. hínun gamla. kononge>

kennddi feðr sín-um hín-um gaml-a
 knew father-DAT.SG. his-DAT.M.SG. the-DAT.M.SG. old-DAT.M.SG.
 konong-e
 king-DAT.SG.

‘[the young king and son] knew his father, the old king, [as his own]’

- d. **H6 fol. 6r32b:** <þeir fem riðu með kononge-n-om>

þeir sem riðu með konong-e-n-om
 they-NOM. who rode with king-DAT.SG.-DEF.-DAT.M.SG.

‘they who rode with the king’

When encliticised, the definite suffix may or may not undergo harmony depending on a number of factors. First, the shape of the suffix varies dialectally. Writers which display the high /-(h)in-/ variant of the article in modified (free-standing) positions – such as H6 in (102c) – feature a high underlying suffix /-in-/. And vice versa, scribes which feature the non-high article /en-/ in modified environments – such as DG8 in (102a) – display an underlying non-high ([open]-specified) enclitic /-en-/. This difference between DG8 and H6 manuscripts in definite suffixes has a significant effect on surface harmony patterns. In DG8, the [open]-specified definite suffix /-en-/ is a non-alternating harmony trigger (103a–d): e.g. /‘hirð-en-ni/ → [‘hirðenne], not *[‘hirðinni]. In contrast, in H6 the /-in-/ is contrastively non-specified for the harmony feature and therefore a harmony target (103e–h), displaying regular high/non-high alternations: e.g. high [‘syndinni] vs. non-high [‘sa:lenne]. This dichotomy between harmonising /-in-/ and non-harmonising /-en-/ is predictable given the privativity of the harmony feature (see section 2.2.1).

(103) Differing (non-)harmonising definite enclitics in DG8 and H6

DG8 non-alternating /-enn/

- | | | | | |
|----|---------------|-------------|--------------|--|
| a. | /‘borg-en-ni/ | [‘borgenne] | <borgenne> | ‘fortification’-DEF.-DAT.F.SG. |
| b. | /‘hirð-en-ni/ | [‘hirðenne] | *[‘hirðinni] | <hirðenne> ‘king’s men’-DEF.-DAT.F.SG. |
| c. | /‘veg-en-um/ | [‘vegenom] | <vegenom> | ‘way’-DEF.-DAT.M.SG. |
| d. | /‘hug-en-um/ | [‘hugenom] | *[‘huginum] | <hugenom> ‘mind’-DEF.-DAT.M.SG. |

H6 alternating /-inn/

- | | | | | |
|----|---------------|-------------|------------|--------------------------|
| e. | /‘sa:l-in-ni/ | [‘sa:lenne] | <faltenne> | ‘soul’-DEF.-DAT.F.SG. |
| f. | /‘synd-in-ni/ | [‘syndinni] | <fyndinni> | ‘sin’-DEF.-DAT.F.SG. |
| g. | /‘stað-in-um/ | [‘staðenom] | <ftaðenom> | ‘place’-DEF.-DAT.M.SG. |
| h. | /‘funt-in-um/ | [‘funtinum] | <funtinum> | ‘meeting’-DEF.-DAT.M.SG. |

5.7.2 Vowel hiatuses and vowel deletions

The rather tidy division in DG8 and H6 patterns in (103) is however complicated by a number of vowel deletions which may disrupt harmony patterns. The initial vowel of the definite enclitic is elided in a few contexts. The generalisation is that when the definite suffix is monosyllabic, its vowel is deleted following unstressed vowels and retained

otherwise (104ab). When polysyllabic (104cd), the definite suffix's initial vowel is deleted in any hiatus (cf. Noreen 1923, pp. 316–18; Iversen 1955, pp. 119–20; cf. Kristján Árnason 2011, pp. 255–57).

(104) **Vowel deletion in vowel hiatuses in H6**

Monosyllabic definite suffix /-in/ NOM.F.SG.

- | | | | | | |
|----|-------------|---|------------|---------|-------------|
| a. | /ʔtru:-in/ | → | [ʔtru:.in] | <truin> | ‘the trust’ |
| b. | /ʔkon-a-in/ | → | [ʔko.nan] | <konan> | ‘the woman’ |

Disyllabic definite suffix /-in-a/ ACC.F.SG.

- | | | | | | |
|----|---------------|---|-------------|----------|-------------|
| c. | /ʔtru:-in-a/ | → | [ʔtru:.na] | <truna> | ‘the trust’ |
| d. | /ʔkon-u-in-a/ | → | [ʔko.no.na] | <konona> | ‘the woman’ |

The data in (104) are taken from H6, but the deletion patterns are equally generalisable to DG8, as shown below in (105). Since the scribe of DG8 features an underlying [open]-specified definite suffix /-en-/ in non-eliding contexts, the vowel surfaces as [open] /e/, as in [ʔsky:-en] (105a), cf. H6 [ʔtru:-in] in (104a). In eliding contexts, this underlying difference between DG8 and H6 is eliminated: e.g. [ʔtru:.na] from both H6 /ʔtru:-in-a/ and DG8 /ʔtru:-en-a/. This difference in eliding and non-eliding contexts has crucial effects on surface harmony patterns as discussed below.

(105) **Vowel deletion in vowel hiatuses in DG8**

Monosyllabic definite suffix /-en/ NOM.F.SG./N.PL.

- | | | | | | |
|----|-------------|---|------------|----------|--------------|
| a. | /ʔsky:-en/ | → | [ʔsky:.en] | <fkkyen> | ‘the clouds’ |
| b. | /ʔkon-a-en/ | → | [ʔko.nan] | <konan> | ‘the woman’ |

Disyllabic definite suffix /-en-a/ ACC.F.SG.

- | | | | | | |
|----|---------------|---|-------------|----------|-------------|
| c. | /ʔtru:-en-a/ | → | [ʔtru:.na] | <truna> | ‘the trust’ |
| d. | /ʔkon-u-en-a/ | → | [ʔko.no.na] | <konona> | ‘the woman’ |

In terms of surface harmony patterns, vowel deletions in the definite suffix do not have much effect on H6 surface harmony patterns. Both eliding environments (106a–d) and non-eliding environments (106e–h) display harmonic alternations consistent with other harmony contexts surveyed thus far. In fact, without surveying the word's whole paradigm, it is not always clear whether vowel deletion has occurred or not: for instance, elided [ʔviðinum] vs. non-elided [ʔfuntinum] (106cg).

(106) **Harmonising and non-harmonising definite suffixes in H6**

Eliding environments

- | | | | | |
|----|------------------|--------------|-------------|------------------------------------|
| a. | /ʔfyrst-u-in-ni/ | [ʔfyrstunni] | <fyrftunni> | ‘beginning’-DAT.SG.-DEF.-DAT.F.SG. |
| b. | /ʔmess-u-in-ni/ | [ʔmessonne] | <meffonne> | ‘mass’-DAT.SG.-DEF.-DAT.F.SG. |
| c. | /ʔvið-i-in-um/ | [ʔviðinum] | <viðinv> | ‘wood’-DAT.SG.-DEF.-DAT.M.SG. |
| d. | /ʔsvøfn-i-n-um/ | [ʔsvøfnenom] | <fuøfnenom> | ‘sleep’-DAT.SG.-DEF.-DAT.M.SG. |

Non-eliding environments

- | | | | | |
|----|---------------|-------------|------------|--------------------------|
| e. | /ʔsynd-in-ni/ | [ʔsyndinni] | <fyndinni> | ‘sin’-DEF.-DAT.F.SG. |
| f. | /ʔbo:k-in-ni/ | [ʔbo:kenne] | <bokenne> | ‘book’-DEF.-DAT.F.SG. |
| g. | /ʔfunt-in-um/ | [ʔfuntinum] | <funtinum> | ‘meeting’-DEF.-DAT.M.SG. |
| h. | /ʔstað-in-um/ | [ʔstaðenom] | <ftaðenom> | ‘place’-DEF.-DAT.M.SG. |

In DG8 by contrast, eliding and non-eliding environments display very different harmony patterns, producing what at first might seem like contradictory data: e.g. harmonic ['viðinum] but disharmonic ['hugenom]; these apparent contradictions have contributed significantly to the confusion around the role and behaviour of definite enclitics in Old Norwegian vowel harmony. Paulsen (2015) identified that these apparent contradictions are morphologically systematic; if the non-definite form has an inflectional vowel, then the word is harmonic – e.g. ['við-i] and ['við-i-num] ‘wood’-DAT.SG./-DAT.SG.-DEF.DAT.M.SG. – otherwise the form is not harmonic – e.g. ['hug] and ['hug-e-nom] ‘mind’-DAT.SG./-DAT.SG.-DEF.DAT.M.SG. In other words, these dis/harmony patterns are a predictable reflex of differing inflectional patterns, which receive a natural explanation assuming privative [open]-spreading in Old Norwegian.

In DG8 forms where the definite suffix attaches to a word-final inflectional vowel, the initial [open]-trigger vowel /e/ is elided (107a–d). The following inflectional vowels therefore harmonise to preceding, non-elided vowels: e.g. /'hyrn-u-en-ni/ → /'hyrn-u-n-ni/ → ['hyrnunni] but /'mess-u-en-ni/ → /'mess-u-n-ni/ → ['messonne]. In other words, vowel deletion feeds vowel harmony. But in comparison, in non-eliding environments such as (107e–h) the underlying [open]-specified /e/ is permitted to surface and triggers vowel lowering on following inflectional vowels, regardless of preceding vowels. This may result in partial harmony at the word-level: e.g. /'hug-en-um/ → ['hugenom].¹¹

(107) Vowel deletion effects on harmony patterns in DG8

Eliding/harmonising environments

a.	/hyrn-u-en-ni/	['hyrnunni]	<hyrnunni>	‘(axe)point’-DAT.SG.-DEF.-DAT.F.SG.
b.	/mess-u-en-ni/	['messonne]	<meffonne>	‘mass’-DAT.SG.-DEF.-DAT.F.SG.
c.	/við-i-en-um/	['viðinum]	<piðinum>	‘wood’-DAT.SG.-DEF.-DAT.M.SG.
d.	/sømn-i-en-um/	['sømnenom]	<foemnenom>	‘sleep’-DAT.SG.-DEF.-DAT.M.SG.

Non-eliding/non-harmonising environments

e.	/'hirð-en-ni/	['hirðenne]	<hirðenne>	‘king’s men’-DEF.-DAT.F.SG.
f.	/'bo:k-en-ni/	['bo:kenne]	<bokenne>	‘book’-DEF.-DAT.F.SG.
g.	/'hug-en-um/	['hugenom]	<hugenom>	‘mind’-DEF.-DAT.M.SG.
h.	/'stað-en-um/	['staðenom]	<ftaðenom>	‘place’-DEF.-DAT.M.SG.

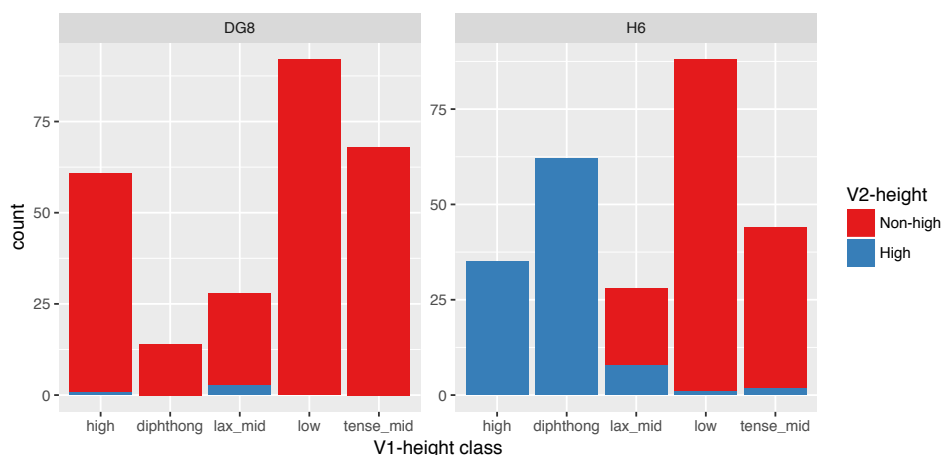
The key insight is that in eliding environments, both manuscripts display fully harmonic surface forms, but in non-eliding environments, H6 displays consistent harmonic [-in-, -en-] definite enclitic alternations where DG8 displays only an underlyingly [open]-specified and therefore non-alternating [-en-] definite suffix.

There is yet one unexplained exception to this generalisation in H6 following lax mid /ɛ, ɔ/ vowels. In Fig. 5.14 I plot the relative height of the definite enclitics in non-eliding

¹¹This is an example of how underlying harmony feature specifications produce seemingly blocked harmony patterns on the surface. The definite suffix and following inflectional suffixes in DG8 (e.g. /-en-um/) function in a similar way to the half-harmonising Turkish progressive suffix /-ijor/ discussed in section 3.3.6, which is historically derived from a verbal stem (Charette & Göksel 1998, p. 69). Turkish displays both labial and backness harmony. The second vowel of the suffix /-ijor/ is pre-specified for both harmony features [labial] and [dorsal] in Turkish, and like non-elided /-en-/ in DG8, the second vowel of /-ijor/ is non-alternating and triggers both harmony patterns on following inflectional vowels regardless of preceding vowels: e.g. [gʲɛlʲ-i-jor-um], *[gʲɛlʲ-i-jir-im] ‘come’-PROG.-1.SG.; [gylʲ-yjor-um], *[gylʲ-yjor-ym] ‘laugh’-PROG.-1.SG.

environments following roots with different vowel heights in both manuscripts.¹² As this plot illustrates, in non-eliding environments, definite enclitics display practically no alternations in DG8 but harmonise like other unstressed suffixes in H6 with the peculiar exception following lax mid vowels /ɛ, ɔ/ in H6. In this latter context, we find considerable variation. Given the phonology of H6, we would expect lax mid vowels – which are neutral/inert with respect to height harmony – to take high suffixes: e.g. /'jɔrð-in/ → ['jɔrðin] ‘earth’-DEF.NOM.F.SG., but the majority of the cases display the opposite, with apparent vowel lowering.

Figure 5.14: Definite enclitic vowel height as a factor of root vowel height



In the entirety of the H6 manuscript (72,562 words), there are only 28 forms with lax mid root vowels with non-elided definite enclitics, half of which belong to the lexeme *jɔrð* ‘earth’. It is thus unfortunately very limited what we can say about the phonology of these rare contexts. Half of *jɔrð* cases (7/14) take high suffixes – e.g. <Jorðin, iorðina> – and half display non-high suffixes – e.g. <iorðen, iorðena>. This kind of variation is uncharacteristic for this manuscript in other environments, and it is not clear what drives this variation. The word *holl* ‘hall’ occurs twice in this context – once with a fully non-high <hollenne> and once with a peculiar partially harmonic <hollenni>, with a high word-final vowel. This latter form displays two unexpected sequences – apparently harmonic [ɔ...e] but disharmonic [e...i]. This may be an indication of rare orthographic or copying influence on harmony spelling patterns. It might be, for example, that the H6 manuscript is copied from an exemplar with DG8-like definite enclitics, which would be <iorðen> and <hollenne> which here competes with the H6-scribe’s own native ['jɔrðin] and ['hollinni] forms, resulting in mixed orthographic patterns like <iorðin>/<iorðen> and <hollenni>. But with so few data, this matter will have to remain unresolved for now.

5.7.3 Vowel deletion and other segmental phonology

With a grasp of the Old Norwegian vowel eliding environments outlined above, there is one more interesting interaction observed in the behaviour of Old Norwegian definite

¹²These data include NOM./ACC./DAT.-SG. feminine inflections (e.g. /'tru:-en/-types), NOM./ACC.-SG. masculine inflections (e.g. /'konong-en-n/-types), and NOM./ACC./GEN.-SG. and NOM./ACC.-PL. neuter inflections (e.g. /'sky:-en/-types).

suffixes. As shown by the examples in (108), *u*-umlaut is blocked by vowel hiatuses, which feeds height harmony: e.g. /'bardag-a-en-um/ → ['bardaganom].¹³ If by contrast, *u*-umlaut and height harmony interacted transparently following vowel deletions – i.e. /'bardag-a-en-um/ → *['bardag-a-n-um] – then we might expect *u*-umlaut subsequently to round /a/ → [ɔ] and to bleed height harmony as elsewhere – i.e. */'bardag-a-n-um/ → ['bardagɔnum], but this is not attested, either in DG8, H6, or any other Norse variety (cf. Old/Modern Icelandic non-umlauted *bardaganum*, not *bardagönum*). Instead, as schematised via an ordered application in (109), *u*-umlaut is strictly local, failing to apply because of the intervening /e/ vowel in /'bardag-a-en-um/ which is subsequently deleted – ['bardag-a-n-um] – after which height harmony applies, lowering /u/ to [o]: ['bardag-a-n-om].

(108) ***U*-umlaut is blocked in /a-en-um/ DAT.SG.-DEF.-DAT.M.SG. inflections, feeding height harmony**

a.	/'bardag-a-en-um/	→	['bardaganom]	<bardaganom>	'battle'
b.	/'dauð-a-en-um/	→	['dauðanom]	<dauðanom>	'death'
c.	/'hǫfðingj-a-en-um/	→	['hǫfðingjanom]	<hǫfðingjanom>	'chieftain'
d.	/'fja:nd-a-en-um/	→	['fja:ndanom]	<fiandanom>	'fiend'

Given that Old Norwegian height harmony is not parasitic on vowel labiality or backness, it is predicted that short /a/ should trigger /u/-lowering to [o] as other low vowels, but harmony is generally bled in this context by *u*-umlaut (e.g. /'bardag-um/ → ['bardɔgum] 'battle'-DAT.PL.), deriving a neutral [ɔ] from /a/. Vowel deletions in definite enclitics provide the only context in which *u*-umlaut is blocked and which confirm this prediction that short /a/ is a valid trigger of /u/-lowering.

(109) **Ordered application of *u*-umlaut, vowel deletion, and height harmony**

DG8 derivations

Underlying	/'við-i-en-um/	/'hug-en-um/	/'bardag-a-en-um/
<i>U</i> -umlaut (vacuous)	'viðienum	'hugenum	'bardagaenum
Vowel deletion	'viðinum	'hugenum	'bardaganum
Height harmony	'viðinum	'hugenom	'bardaganom
Orthography	<viðinum>	<hugenom>	<bardaganom>

H6 derivations

Underlying	/'við-i-in-um/	/'funt-in-um/	/'fja:nd-a-in-um/
<i>U</i> -umlaut (vacuous)	'viðiinum	'funtinum	'fja:nda _i inum
Vowel deletion	'viðinum	'funtinum	'fja:nda _i num
Height harmony	'viðinum	'funtinum	'fja:ndanom
Orthography	<viðinvm>	<funtinum>	<fiandanom>

As these patterns illustrate, the unique behaviour of Old Norwegian definite enclitics is well-understood once the complex interaction between dialectal, inflectional, and vowel deletion/umlaut contextual differences are taken into consideration. Intervening featural specification and simple interactions with orthogonal vowel deletion and umlaut processes

¹³The data in (108) are taken from DG8, but as shown in (109) the surface patterns would be identical in H6 since the definite enclitic vowel is elided in these cases.

produce the definite suffix's intricate surface patterns. As a practical summary of the definite enclitic patterns in H6 and DG8, three singular masculine declension paradigms for *viðr* 'wood', *bardagi* 'battle', and *hugr* 'mind' are provided below for H6 in (II0) and DG8 in (III).

(II0) **H6 masculine singular inflections**

	INDEF.	DEF.	INDEF.	DEF.	INDEF.	DEF.	
NOM.	hug-r	hug-r- <u>in</u> -n	við-r	við-r- <u>in</u> -n	bardag-e	bardag-e- <u>n</u> -n	/-in-n/
ACC.	hug-	hug- <u>in</u> -n	við-	við- <u>in</u> -n	bardag-a	bardag-a- <u>n</u> -n	/-in-n/
DAT.	hug-	hug- <u>in</u> -um	við-i	við-i- <u>n</u> -um	bardag-a	bardag-a- <u>n</u> -om	/-in-um/
GEN.	hug-ar	hug-ar- <u>en</u> -s	við-ar	við-ar- <u>en</u> -s	bardag-a	bardag-a- <u>n</u> -s	/-in-s/

(III) **DG8 masculine singular inflections**

	INDEF.	DEF.	INDEF.	DEF.	INDEF.	DEF.	
NOM.	hug-r	hug-r- <u>en</u> -n	við-r	við-r- <u>en</u> -n	bardag-e	bardag-e- <u>n</u> -n	/-en-n/
ACC.	hug-	hug- <u>en</u> -n	við-	við- <u>en</u> -n	bardag-a	bardag-a- <u>n</u> -n	/-en-n/
DAT.	hug-	hug- <u>en</u> -om	við-i	við-i- <u>n</u> -um	bardag-a	bardag-a- <u>n</u> -om	/-en-um/
GEN.	hug-ar	hug-ar- <u>en</u> -s	við-ar	við-ar- <u>en</u> -s	bardag-a	bardag-a- <u>n</u> -s	/-en-s/

These paradigms display patterns with and without vowel deletions – *viðr* / *bardagi* vs. *hugr*, respectively – and with and without potential *u*-umlaut contexts – *bardagi* vs. *viðr* / *hugr*, respectively. For clarity's sake, inflectional vowels are marked in bold and the definite enclitic is marked by underlining in (II0–III).

5.8 Summary

In this chapter, I have provided an overview of the important empirical generalisations of Old Norwegian vocalic grapho-phonology. This survey of graphic-phonetic correspondences suggests that phonological annotations based on Holthausen's (1948) reconstructions are consistent and coherent. Depending on ongoing vowel mergers, Old Norwegian displays three contrastive diphthongs and between 9–10 qualitatively distinctive monophthongs, the majority of which display additional length distinctions. Pervasive variation in [ɛ]–<æ, e> and [ɔ]–<o, a> spelling can be understood chiefly as effects of sound-letter inventory asymmetries, ongoing /e, ɛ/ mergers, and in certain contexts the /a/–/ɔ/ contrast-neutralising effect of *u*-umlaut. Old Norwegian vowels are not evenly distributed in stressed and unstressed syllables. All vowels occur in root-initial (stressed) syllables. Only the peripheral vowels /i, a, u/ regularly occur in other positions, and [e, o] are regularly derived via height harmonic lowering in unstressed (non-initial) syllables.

Using these phonological annotations, this chapter has provided an outline of vowel harmony and harmony decay across the corpus. This survey has confirmed that vowel harmony applies categorically in the DG8/H6 manuscripts, which provide ample, high quality data for exploring Old Norwegian vowel harmony in detail. The other manuscripts in this corpus display transitional or post-harmony decay phonological grammars, which are empirically important specimens in their own right. The loss of vowel harmony (harmony decay) is indirectly known to have occurred in a number of languages, but the pre-, transitional, and post-decay stages of this process have never been fully documented in any contemporary or historical linguistic record (cf. Kavitskaya 2013; McCollum 2015,

2018; Bobaljik 2018). In this initial survey, I have documented pre-decay stages in the DG8/H6 manuscripts, transitional stages are displayed by the DG4_7_h1/2 scribes, and post-harmony decay stages are documented in the AM243/H17 manuscripts. The Norwegian historical record thus provides a unique and important glimpse into this rare phonological development, and this initial investigation lays good groundwork for future research on Old Norwegian harmony decay.

The patterning of Old Norwegian vowel harmony in many contexts presents quite a number of unresolved riddles: e.g. what are the harmony, neutrality, and blocking patterns of different vocalic classes? What causes some derivational suffixes to harmonise and not others? What causes the partially harmonising behaviour of many definite enclitics? In this chapter, I have provided a detailed survey of the fundamental vowel patterns in the harmony manuscripts DG8/H6. This survey demonstrates that harmony and harmony exceptions are systematic in these manuscripts. This study illustrates broadly three vowel classes: i.e. fully harmonising [e, ø, o, i, y, u]; neutral blocking [ɛ, ɔ], and harmonic blocking [æ, a] vowels. This survey demonstrates that there are two classes of derivational suffixes in Old Norwegian, whose differing harmony behaviour is likely an effect of differing stress as shown by a parallel stressed/unstressed division in the phonological behaviour of etymologically related derivational suffixes in Modern Icelandic. Finally, I have shown that the very complex surface patterns of definite enclitics is the aggregate effect of dialectal variation in the relative height of the enclitic vowel /-in-/ vs. /-en-/, which is deleted to avoid hiatuses created when suffixed to vowel-final roots.

In sum, while the Old Norwegian vowel inventory, grapho-phonology, and vowel harmony are very complex, the sources of variation and apparent exceptions are, in general, highly systematic and now well understood. Methodologically, this corpus study demonstrates the value of detailed philological methods in securing high-quality and reliable phonological data. Phonologically, the rare attestation of harmony decay and detailed documentation of intricate harmony interactions with intervening sound changes (e.g. vowel mergers) and orthogonal sound processes (e.g. umlauts, vowel deletions) prove Old Norwegian to be a typologically highly significant harmony language.

Chapter 6

Old Norwegian vocalic features and harmony analysis

The surface harmony generalisations in the foregoing chapter provide rich evidence for Old Norwegian vocalic classes and sound processes. In this chapter, I illustrate how we can use this phonological evidence to interpret Old Norwegian segmental features and feature specifications according to the contrastive hierarchy method, as outlined in chapters 2–3. Before taking up the analysis of Old Norwegian vowels and vowel harmony, I provide a short review of the contrastive hierarchy approach in section 6.1. This is a substance-free framework which incorporates emergent features (e.g. Mielke 2008, Iosad 2017a) which are assigned to a set of segments on the basis of phonological evidence in the way of contrasts and alternations. Using this method, I deduce the set of active vocalic features in Old Norwegian as evidenced by phonological activity in section 6.2. Feature specifications on individual segments (and therewith the ultimate shape of feature classes) are further inferred by their visibility to phonological processes. Old Norwegian harmony blocking effects and certain umlaut patterns provide ample diagnostics. In section 6.3 I provide a full licensing account of Old Norwegian height harmony, which follows from the representational generalisations defined in section 6.2. This analysis illustrates how even complex vowel inventories and vowel harmony systems as those found in Old Norwegian may be understood as the emergent products of language-particular feature specifications and contrasts defined by the contrastive hierarchy. Old Norwegian vowel harmony patterns have important implications for the nature of Old Norwegian *j*-, *i*- and *u*-umlaut processes. I explore these interactions in section 6.4, and I provide an overall summary of these analyses in section 6.5.

6.1 Contrastive hierarchy method review

The representational theory advocated in this thesis builds on Contrastive Hierarchy Theory or Modified Contrastive Specification (Dresher, Piggott & Rice 1994; D. C. Hall 2007; Dresher 2003, 2009; Iosad 2017a). In section 2.3 I have demonstrated how a language's sound inventory and segmental representations may be defined using emergent and substance-free phonological features and feature-nodes (cf. Iosad 2017a, Dresher 2018). This approach relies on two principal components: 1) the Correlate Contrastivist Hypothesis (CCH) defined in (32), adapted from D. C. Hall (2007, p. 20), which holds

that ‘the phonemes of a language L are equal to the sum of features and feature co-occurrence restrictions which are minimally necessary for the expression of phonological regularities in L ’, and 2) that the set of features and feature co-occurrence restrictions identified according to the CCH are specified on segments in correspondence with the Successive Division Algorithm defined in (39), adapted from D. C. Hall (2007, p. 31). From these two components it holds that a language’s set of required phonological features are generalisable on the basis of phonological in/activity (i.e. segmental contrasts and alternations) and the shape of feature classes are generalisable on the basis of asymmetries in phonological in/visibility (e.g. non-/transparency in feature spreading processes). This representational framework provides an account of where features come from and how they combine to produce higher hierarchical structures (i.e. segments, feature classes, whole inventories). As a corollary, this representational approach produces an easily implemented harmony methodology which provides a unified account of harmony/neutral harmony and the broad typological relationship between inventory asymmetries and harmony variation.

In sections 6.2–6.3 below, I provide featural and harmony analyses of Old Norwegian vowel patterns. In preview to the analyses below, contrasts and alternations in Old Norwegian demonstrate four vowel classes which play an important role in the understanding of Old Norwegian vowel harmony, which I have labeled [open, low] /æ, a/, [lax] /ɛ, ɔ/, [open] /e, ø, o/, and height non-specified /i, y, u/. Following this contrastive hierarchy framework, the Old Norwegian vowel inventory and vowel height harmony system is not unlike other structurally related Bantu height harmony systems outlined in chapters 2/3.

Like previous formulations of the theory, this approach formalises the role phonological representations play in deriving different forms of harmony and harmony neutrality. The harmony generalisations reported and outlined in section 5.4 indicate Old Norwegian vowel harmony involves privative [open]-spreading from stressed to unstressed syllables. As a result of multiple inventory asymmetries, we observe a rare combination of both harmonic and neutral blocking vowels in Old Norwegian. These patterns are known to occur independently in other height harmony systems (cf. for example harmonic blocking Mbunda (K.15) vs. neutral blocking Chewa (N.31) previously discussed in section 1.2) but never together in one and the same lowering harmony system.¹

I have argued that asymmetries in sound inventories and harmony neutrality such as harmonic and neutral blocking have a common cause – restrictions on feature co-occurrence (cf. section 3.1). In particular, Old Norwegian contrasts and height harmony blocking asymmetries evidence two important feature co-occurrence restrictions – prohibited *[open, lax] and obligatory [open, low] co-occurrence. That is, [lax] vowels are illicit recipients of [open] – by which [lax] /ɛ, ɔ/ cause neutral blocking – and any [low] vowel is necessarily specified [open] – making [open, low] /a, æ/ non-alternating targets but nevertheless harmony triggers (i.e. harmonic blockers). This representational architecture provides a principled and concise illustration of the way in which the complexity of a language’s harmony system and the complexity of its sound inventory are intrinsically linked.

¹Though confer a comparable example of harmonic blocking /a/ and neutral blocking /i, u/ in Standard Yoruba tongue root harmony discussed in sections 3.1.3.

6.2 Features and feature co-occurrence restrictions

According to the CCH, a language learner deduces her language's set of phonological features and feature co-occurrence restrictions from phonological patterning; that is, categorical contrasts and alternations. In this section, I demonstrate the representational cues evidenced by Old Norwegian segmental phonology using the Old Norwegian surface generalisations made in chapter 5. The sum of these cues define Old Norwegian's set of vocalic phonological features, segments, classes, and full vowel inventory. When investigating any language's phonological features, we could begin by exploring any set of contrasts or alternations; the choice is arbitrary. Since Old Norwegian displays height harmony, let us begin with height-related features.

6.2.1 [open]; *[open, lax] > [lax]

Old Norwegian displays a form of height harmony. Height contrasts and height harmonic alternations between high [i] and non-high [e] in (112) evidence some contrastive aperture feature, for example [close] or [open].

(112) Close-mid [i]–[e] contrasts and harmonic alternations

- | | | | |
|-------|---------|---------|-----------------------|
| a. | 'tig-ir | <tigir> | 'ten, decade'-ACC.PL. |
| b. | 'bið-it | <biðit> | 'beg'-IMP.2.PL. |
| <hr/> | | | |
| c. | 'veg-er | <veger> | 'way'-NOM.PL. |
| d. | 'beð-et | <beðet> | 'beg'-PRET.PART. |

On their own, the contrasts and alternations in (112) do not indicate what the relevant dominant/recessive feature asymmetry is; that is, whether the relevant marked/unmarked relation is [close] /i/ vs. non-close /e/ (as in Pasiego Montañes Spanish raising harmony, Vago 1988) or rather [open] /e/ vs. non-open /i/ (as in canonical Bantu lowering harmony, Odden 2015). To establish language-specific featural markedness differences, we require some asymmetry in contrasts and alternations, which is provided in Old Norwegian by neutral lax vowels below. The data in (113) provide a number of minimal- and near minimal-pairs which demonstrate a distinction between harmonic /e/ and disharmonic /ɛ/ vowels. In other words, /e/ triggers harmonic lowering (e.g. /'gerðisk/ → ['gerðesk]) whereas /ɛ/ does not (e.g. /'berðisk/ → ['berðisk]). We may characterise this distinction as a difference between a [lax] or [tense] feature.

(113) Mid vowel [e] – [ɛ] contrasts

- | | | | |
|-------|------------|-----------|-----------------------------|
| a. | 'gerð-e-sk | <gerðezc> | 'do'-PRET.3.SG.-REFLEX. |
| b. | 'feng-e | <fenge> | 'get'-PRET.3.SG.SUBJ. |
| <hr/> | | | |
| c. | 'berð-i-sk | <bærðizc> | 'strike'-PRET.3.SG.-REFLEX. |
| d. | 'feng-it | <fængit> | 'get'-PRET.PART. |

In sum, the contrasts and alternations in (112, 113) above evidence the basic featural distinctions in (114). In other words, in order to express the contrasts below, we need to assume two features – one of which I here label as [close]/[open] and one of [tense]/[lax]. Which label the speaker assumes comes down to each feature's marked/unmarked classes.

For instance, it may be debated whether the relevant contrast is harmonising [tense] /e, i/ vs. non-harmonising, non-tense /ε/ or the reverse: [lax] /ε/ vs. non-lax /e, i/. In other words, is harmony limited to [tense] or non-lax vowels?

(114) **Alternative Old Norwegian height and tense marked feature specifications**

i	–	i	[close]	e	–	e	[tense]
			or				or
e	–	e	[open]	ε	–	i	[lax]

Solving such asymmetries resembles a sudoku puzzle; given the right evidence, one value or feature indicates or excludes another. Once we have worked out one of the features, we can deduce the others. In the case of Old Norwegian, vowel height harmony patterns provide explicit evidence of aperture feature specifications.² To disambiguate the necessary feature labels in (114), we require two crucial pieces of evidence. These are provided by contrasts in phonological behaviour between harmonising tense /e, i/ vowels and neutral lax /ε/. First, the disharmonic [ε...i] sequences suggest that Old Norwegian height harmony involves [open]-triggered vowel lowering rather than [close]-raising since a [close]-analysis would require raising following both /i/ and /ε/ (e.g. ['fɛŋg-it] and ['bið-it]) rather than only lowering following [open] /e/ (e.g. ['beð-et]). Second, in unstressed / non-initial (target) positions, /ε/ displays no alternations and does not permit long distance spreading, as demonstrated by the data in (115) below: for example, /'akkɛr-i/ → ['akkɛri], not *['akkɛre].³ In other words, /ε/ is a visible but illicit recipient of [open]-harmony; an example of neutral blocking. In the contrastive hierarchy approach, neutral blocking patterns indicate the segment is specified for some feature [G] within the scope of feature [F], which are prohibited from co-occurring (i.e. *[F, G]), resulting in [F]-harmony blocking. In the case of Old Norwegian, these data demonstrate that /ε/ must be specified for some feature which /e, i/ lack – let us label it [lax] – which is prohibited from co-occurring with the harmony feature (i.e. *[open, lax]).

(115) **[ε] is a neutral blocker, evidencing prohibited *[open, lax] co-occurrence**

- | | | | | |
|----|-----------|-----------|------------------|-----------|
| a. | 'mɪssɛr-i | <misseri> | 'season'-ACC.PL. | |
| b. | 'mɪstɛr-i | <misteri> | 'temple'-ACC.PL. | |
| c. | 'akkɛr-i | <Akcæri> | 'anchor'-ACC.SG | *'akkɛr-e |
| d. | 'altɛr-i | <allteri> | 'altar'-DAT.SG. | *'altɛr-e |

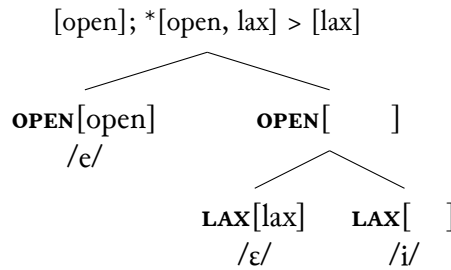
In summary, the data in (112–115) evidence the following representational micro-cues: two features – which we have labeled [open]/[lax] – and the co-occurrence restriction *[open, lax] prohibiting an [(open), lax] /ε, i/ contrast. So far these generalisations produce a three-way distinction: [lax] /ε/, [open] /e/, and non-specified [] /i/. [lax] /ε/

²See section 6.3 below for a full analysis of Old Norwegian height harmony and neutral harmony patterns.

³In Old Norwegian there are no examples of [ε...ε] vowel sequences in morphologically simplex words. As shown in the next section, /a/ is a harmony trigger and is therefore used in (115) to demonstrate non-initial-/ε/ [open]-harmony blocking patterns. Note that [ε] which generally lacks any unique letter in Old Norwegian writing is variably spelled <æ, e>. Lax vowel orthography in Old Norwegian is explored in detail in sections 5.1.1/5.1.2.

has been shown to be visible to [open]-harmony, which indicates that [open] has broadest scope ([open] > [lax]), such that [lax] vowels are contrastive for [open] and therefore have an **OPEN** feature-node.

Figure 6.1: Old Norwegian preliminary [open]/[lax] contrasts



Together these inferences – [open]; *[open, lax] > [lax] – define the preliminary contrastive hierarchy in Fig. 6.1. That is, Old Norwegian vowels are divided into [open] and non-open contrasts, where non-open vowels display a finer [lax]/non-lax distinction. All segments are visible to [open]-harmony.

6.2.2 [open, low]

The fourth class of vowels relevant to height harmony patterning in Old Norwegian are low vowels. A number of /e, a/ contrasts and harmony patterns are provided in (116), using DAT.F.SG./NOM.M.PL. adjectival /-ri, -ir/ suffixes. These contrasts evidence a second aperture feature, which we may label [low].

(116) **Mid-low [e, a] vowel contrasts**

a.	'mest-re	<mestre>	'mest-er	<mester>	'most'-DAT.F.SG./NOM.M.PL.
b.	're:tt-re	<rettre>	're:tt-er	<retter>	'straight'-DAT.F.SG./NOM.M.PL.
c.	'all-re	<allre>	'all-er	<aller>	'all'-DAT.F.SG./NOM.M.PL.
d.	'va:nd-re	<vanndre>	'va:nd-er	<vannder>	'bad'-DAT.F.SG./NOM.M.PL.

We observe that both (non-lax) mid and low vowels are [open]-harmony triggers: e.g. NOM.M.PL. /'mest-ir/ → ['mest-er] and /'all-ir/ → ['all-er]. This demonstrates that [low] vowels like mid /e/ must additionally be specified [open]. However, [low] vowels do not display [(open)]-harmony alternations or contrasts. Non-initial low vowels may therefore result in mixed harmony patterns in trisyllabic words: e.g. [open] ['le:tt-ar-e] but [open]/non-open ['li:k-ar-e], not *['li:k-ər-i] or something of the sort (117). This is an example of so-called 'harmonic blocking' – a segment obligatorily specified for the harmony feature, which therefore displays no harmonic alternation but nevertheless triggers harmony.

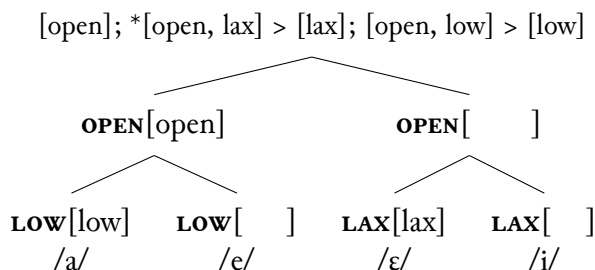
(117) **Non-initial [a] is harmonic blocking**

a.	'li:k-ar-e	~	'le:tt-ar-e	<likare, lettare>	'likely, light'-COMP.-NOM.F.SG.
b.	'rifn-að-e	~	'vesn-að-e	<rifnaðe, vesnaðe>	'crack, worsen'-PRET.-3.SG.
c.	'biðj-and-e	~	'ber-and-e	<biðiannde, berannde>	'bid, bear'-PRES.PART.-NOM.M.SG.
d.	'skilnað-e	~	'getnað-e	<skilnaðe, getnaðe>	'separation, conception'-DAT.SG.

[low] vowels are thus specified [open] – initiating harmonic lowering – but are unpaired with respect to [open] – therefore (neutral) non-alternating, as also found in Mbunda (K.15, [Gowlett 1970](#)) or Pende (L.11/K.52, [Hyman 1999](#), pp. 242–43), previously discussed in section 1.2.2. This distribution evidences obligatory [open, low] co-occurrence. Obligatory [F, G] co-occurrence cues stipulate that a narrower scope [G] feature must be licensed by the broader scope [F] feature – that is, effectively any [low] vowel must also be specified [open], producing asymmetric [low] contrasts: i.e. [open, low] /a/, [open] /e/, non-open/non-low /i/ (that is, there is no non-open [low] vowel in Old Norwegian).

In summary, contrasts and alternations in Old Norwegian basic harmony patterns explored above evidence three phonological features, which I have labelled [open], [lax], and [low]. Moreover, Old Norwegian harmony patterns demonstrate two feature co-occurrence restrictions: [open, low] and *[open, lax]. These define the contrastive hierarchy in Fig. 6.2.

Figure 6.2: Old Norwegian preliminary [open], [lax], [low] contrasts



These features and feature co-occurrence restrictions produce four vowel classes: the harmonic blocking [open, low] /a/, the harmony trigger [open] /e/, the neutral blocker [lax] /ε/, and the harmony target non-specified [] /i/. These feature classes alone are sufficient to account for all basic harmony patterns in Old Norwegian, as explored in greater detail below in section 6.3. Before turning to the harmony analysis, however, I explore the remaining vocalic featural contrasts in Old Norwegian below.

6.2.3 [coronal], [labial, coronal], *[low, labial], and *[lax, labial]

The manuscript corpus displays a three-way distinction in backness and rounding in high/mid vowels /i, y, u/ ~ /e, ø, o/ and two-way distinctions in lax /ε, ɔ/ and low /a, æ/ vowels.⁴ Near minimal labial distinctions are provided below in (118) and corresponding front/back contrasts in (119).

(118) Labial/non-labial [i, e] – [y, ø] contrasts

- | | | | | | |
|----|---------|---|---------|----------------|-----------------------------|
| a. | 'ligg-r | ~ | 'hygg-r | <liggr, hyggr> | 'lie, think'-PRES.3.SG. |
| b. | 'bi:ð-r | ~ | 'by:ðr | <biðr, byðr> | 'bide, bid'-PRES.3.SG. |
| c. | 'feng-e | ~ | 'høgg-e | <fenge, hœgge> | 'get, chop'-PRET.SUBJ.3.SG. |
| d. | 'se:tt | ~ | 'rø:tt | <settt, røtt> | 'see, speak'-PRET.PART. |

⁴Note, however, that Early Old Norwegian did display a [low, (labial)] contrast /a:/~ /v:/, which merged around c 1200.

(119) **Front/back [y, ø, ε, æ] – [u, o, ɔ, a] contrasts**

- | | | | | | |
|----|----------|---|----------|------------------|-------------------------------------|
| a. | 'spyr-ði | ~ | 'spur-ði | <spyrði, spurði> | 'ask'-SUBJ./INDIC.PRET.3.SG. |
| b. | 'bry:nn | ~ | 'bru:n | <brynn, brun> | 'eye-brow'-ACC.PL./DAT.SG. |
| c. | 'øfr-e | ~ | 'offr-e | <øfre, ofre> | 'upper, offering'-NOM.M.SG./DAT.SG. |
| d. | 'fø:t-r | ~ | 'fo:t-r | <føetr, fotr> | 'foot'-NOM.SG./PL. |
| e. | 'eld-a | ~ | 'fjōld-a | <ællda, fiollda> | 'fire, multitude'-ACC.PL. |
| f. | 'mæ:tt-e | ~ | 'ma:tt-e | <mætte, matte> | 'may'-SUBJ./INDIC.PRET.3.SG. |

These distinctions raise a number of questions. First, as with any featural contrast, what are each feature's marked and unmarked classes? For example, is it [coronal] /y/ vs. non-coronal /u/ or [dorsal] /u/ vs. non-dorsal /y/? Second, how do labial/non-labial distinctions relate to front/back distinctions? Old Norwegian displays asymmetric, three-way /i, y, u/ backness and labial distinctions in contrast to a symmetric, four-way /i, y, u, u/ inventory as found, for example, in Turkish. The asymmetry in Old Norwegian indicates that there is some co-occurrence restriction on one of the two features. Third, which feature distinguishes [lax] and [low] vowels? Lax and low vowels display only a binary distinction. For example, is the contrast between ['elda] – ['fjōlda] one of backness or rounding? Finally, how do backness and labial features relate to the previously established [open], [low], and [lax] features in Old Norwegian? As this outline already demonstrates, the relationship between backness, labial, and other features is relatively complex in Old Norwegian – displaying multiple kinds of asymmetries across different vowel heights. Let us work through a possible solution, treating each of the above questions individually.

First, in terms of front/back /y, u/ or /ø, o/ markedness asymmetries, Old Norwegian displays a form of palatalisation following [j] (so-called *j*-umlaut) which provides some insights. As illustrated in (120), /a/ is palatalised to [æ] immediately following [j], which suggests an active, palatalising [coronal] feature. In comparison, there is no clear evidence of any backing [dorsal] feature in Old Norwegian.

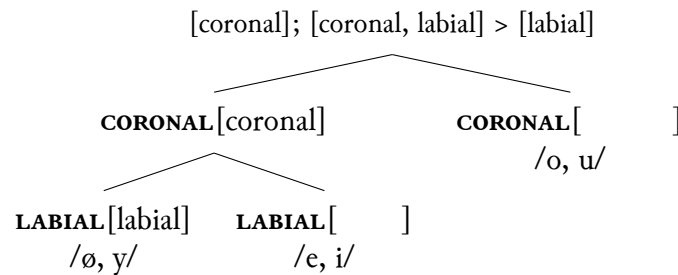
(120) **Palatalising *j*-umlaut /ja/ → [jæ]**

- | | | | | | |
|----|-------------|---|-------------|-----------|----------------|
| a. | /'fjarri/ | → | ['fjærrē] | <fiærre> | 'far off' ADV. |
| b. | /'gjaf-ir/ | → | ['gjæv-er] | <giæver> | 'gift'-ACC.PL. |
| c. | /'gjald-a/ | → | ['gjæld-a] | <giællda> | 'pay'-INF. |
| d. | /'frjals-a/ | → | ['frjæls-a] | <friælsa> | 'free'-INF. |

The data in (120) suggest the backness marked/unmarked asymmetry in the contrasts in (119) is [coronal] /i, y/ vs. non-coronal /u/. How then do coronal/non-coronal distinctions relate to labial/non-labial contrasts? The Old Norwegian vowel inventory is considerably uneven in this respect, and the answer to this question depends on the vowels' height class. First, as shown above in (118–120), [low] vowels do not display [low, (labial)] /a, *ɒ/ contrasts during this period and are contrastive for [coronal] as evidenced by their visibility to *j*-umlaut. This evidences a *[low, labial] co-occurrence restriction prohibiting *[low, labial] */ɒ/. [low] vowels are thus internally distinguished only by [coronal], which may suggest that [coronal] has broader scope than [labial]. Second, in (tense) mid and high vowels, we observe parallel three-way distinctions in [coronal, (labial)] contrasts /e, ø, o/–/i, y, u/. Assuming [coronal] has broader scope, this asymmetric three-way contrast implies obligatory [coronal, labial] co-occurrence. In other words, this means [labial] is

only contrastive among [coronal] vowels – producing a labial contrast between /e, i/ vs. /ø, y/ which is lacking among non-coronal vowels /o, u/ (* /ʌ, ʊ/). Back (non-coronal) vowels are underspecified for [labial]. This is illustrated in the [coronal]; [coronal, labial] > [labial] contrastive hierarchy in Fig. 6.3. The obligatory [coronal, labial] co-occurrence restriction evidenced together by low and mid/high vowel contrasts implies that [lax] /ɛ, ɔ/ vowels are minimally distinguished by [coronal] and not [labial]. As with [low] vowels, the lack of corresponding three-way coronal/labial contrasts among [lax] vowels implies a *[lax, labial] co-occurrence restriction – resulting in the permitted/prohibited contrasts [lax, coronal] /ɛ/, *[lax, labial] */œ/, and [lax] /ɔ/.

Figure 6.3: Old Norwegian preliminary [coronal]/[labial] contrasts



As mentioned earlier, the distribution of labial and coronal contrasts is fairly complex and uneven across Old Norwegian height classes. In the way of a summary, the important insights are that high/mid vowels display a three-way distinction, resulting in [coronal, labial] /ø, y/, [coronal] /e, i/, and non-coronal /o, u/. Lax and low vowels display a parallel, binary distinction due to additional *[low, labial] and *[lax, labial] restrictions; that is, [lax, coronal] /ɛ/ vs. [lax] /ɔ/ and similarly [low, open, coronal] /æ/ vs. [low, open] /a/.

The final matter we need to establish is how coronal/labial contrasts relate to the aperture/manner [open], [low], and [lax] features evidenced by height harmony and harmony neutral patterns in sections 6.2.1/6.2.2. In section 3.3, we saw how harmony/orthogonal feature scope asymmetries produce different (non-/parasitic) harmony asymmetries. Specifically, where the harmony feature has broadest scope, harmony applies symmetrically regardless of other feature specifications. A schematised height harmony example is provided in (121a) using non-parasitic South Kongo (H.16a) mid/high vowel harmony sequences (Hyman 1999, pp. 241–42). In this case, [open] must have broader scope than [labial] since [open]-harmony is not dependent on labial feature-specifications. By contrast, where the harmony feature is parasitic or dependent on another feature, harmony displays marked/unmarked asymmetries with respect to the orthogonal feature. A height harmony example is illustrated in (121b) by Chewa (N.31) where [open]-harmony is contingent on [labial] such that labial vowels will only harmonise with other labial vowels – e.g. [e...u], not *[e...o]. In Chewa this implies that [open] has narrower scope than [labial].

(121) Non-/parasitic harmony sequences in South Kongo/Chewa

<u>i</u> -i	<u>i</u> -u
<u>u</u> -i	<u>u</u> -u
<u>e</u> -e	<u>e</u> -o
<u>o</u> -e	<u>o</u> -o

(a) South Kongo (H.16a): [open] > [labial]

<u>i</u> -i	<u>i</u> -u
<u>u</u> -i	<u>u</u> -u
<u>e</u> -e	<u>e</u> -u
<u>o</u> -e	<u>o</u> -o

(b) Chewa (N.31): [labial] > [open]

In Old Norwegian, we have observed that height harmony displays no Chewa-type dependency on trigger/target agreement for other features, as illustrated by the data in (122), repeated from (91). [open]-harmony in Old Norwegian is non-parasitic and not dependent on [coronal]/[labial] feature-specifications in any way. This demonstrates that Old Norwegian is similar to South Kongo; [open] has broad scope and [coronal]/[labial] feature specifications have narrower scope.

(122) Symmetric height harmony in Old Norwegian coronal/labial suffixes

a.	'skip-i	<flkipi>	'skip-um	<flkipum>	'ship'-DAT.SG./PL.
b.	'dy:r-i	<dyri>	'dy:r-um	<dyrum>	'animal'-DAT.SG./PL.
c.	'hu:s-i	<hufi>	'hu:s-um	<hufum>	'house'-DAT.SG./PL.
d.	'veg-e	<vege>	'veg-om	<vegom>	'way'-DAT.SG./PL.
e.	'dø:m-e	<døme>	'dø:m-om	<dømom>	'example'-DAT.SG./PL.
f.	'do:m-e	<dome>	'do:m-om	<domom>	'judgement'-DAT.SG./PL.

In summary, Old Norwegian displays a number of asymmetrically distributed coronal and labial contrasts. Given the asymmetric shape of the Old Norwegian vowel inventory, the relationship between coronal/labial features and their relation to other Old Norwegian vocalic features is somewhat complex. As I shown in this section, coronal/labial distinctions may be construed in Old Norwegian using the following representational micro-cues – [coronal; *[low, labial]; *[lax, labial]; [coronal, labial] > [labial] – which crucially must have narrower scope than harmony [open]-feature divisions.

6.2.4 Summary of Old Norwegian vocalic features

This section has illustrated how regularities in orthographic and phonological contrasts and alternations in Old Norwegian manuscripts evidence the set of features and feature co-occurrence restrictions which define the Old Norwegian vowel inventory. In particular, Old Norwegian contrasts and alternations in vowel height harmony, *j*-umlaut palatalisation, and labial/non-labial contrasts evidence five features – [open], [lax], [low], [coronal], and [labial]. Height harmony neutral blocking [lax]-vowels evidence a co-occurrence restriction against *[open, lax], and in the same fashion harmonic blocking [low]-vowels indicate obligatory [open, low] co-occurrence. Other inventory asymmetries demonstrate a number of additional restrictions; namely, the asymmetric three-way /i, y, u/ distinction is captured by obligatory [coronal, labial] co-occurrence which prohibits non-coronal

[labial]/non-labial /u/–*/ʉ/ contrasts. Furthermore, the lack of labial contrasts in low and lax vowels evidence additional co-occurrence restrictions: *[low, labial] (i.e. no /a/–*/ɒ/ distinction), *[lax, labial] (i.e. there is no three-way contrast between *[lax, labial] */œ/, [lax, coronal] /ɛ/, and [lax] /ɔ/). The combination of these features and feature co-occurrence constraints define the inventory in (123), consisting of ten vowels. Symmetric or non-parasitic [open]-harmony patterns evidence that [open] has broadest scope. The full contrastive feature hierarchy for Old Norwegian evidenced in this section is provided in Fig. 6.5.

(123) **Old Norwegian vocalic features and feature co-occurrence]**

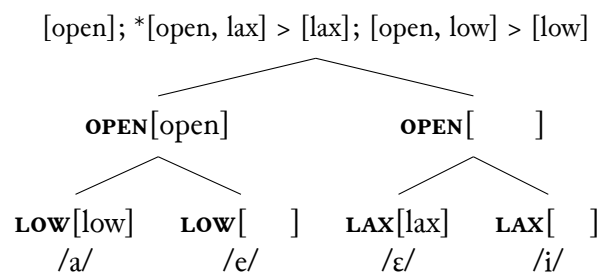
[]	/u/	[coronal]	/i/
[coronal, labial]	/y/	[open]	/o/
[open, coronal]	/e/	[open, coronal, labial]	/ø/
[lax]	/ɔ/	[lax, coronal]	/ɛ/
[open, low]	/a/	[open, low, coronal]	/æ/

With a firm grasp of Old Norwegian vocalic features and feature co-occurrence restrictions, we can explore a full contrastive hierarchy analysis of Old Norwegian height harmony and related vocalic phenomena.

6.3 A representational analysis of Old Norwegian harmony

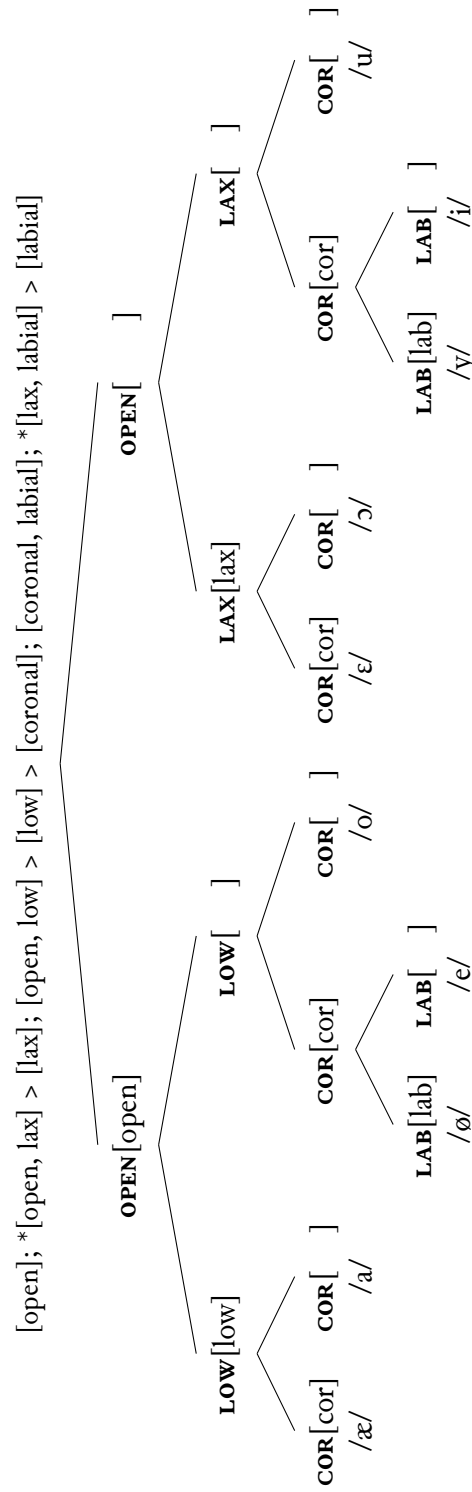
Following the Correlate Contrastivist Hypothesis, an examination of Old Norwegian vowel contrasts and alternations produces the representations in Fig. 6.5. In this section, I show how Old Norwegian height harmony, harmony blocking effects, and apparent exceptionally non-harmonising segments and morphemes are predicted and concisely explained by these representations. For the vast majority of Old Norwegian vowel harmony patterns, we only need to concern ourselves with the aperture/manner contrasts outlined in Fig. 6.6, repeated from Fig. 6.2.

Figure 6.6: Old Norwegian height harmony relevant contrasts



The basic insights of Old Norwegian height harmony can be captured by the simple licensing principle in (124). This licensing approach is adapted from Iosad (2017a, pp. 52–54) and Walker (2005). As further outlined in section 3.2, the principle in (124) specifies 1) what positions harmonise and 2) for what feature. In Old Norwegian, this principle states that vowels in unstressed positions which are contrastive for the harmony feature

Figure 6.5: Old Norwegian vocalic features and feature co-occurrence restrictions

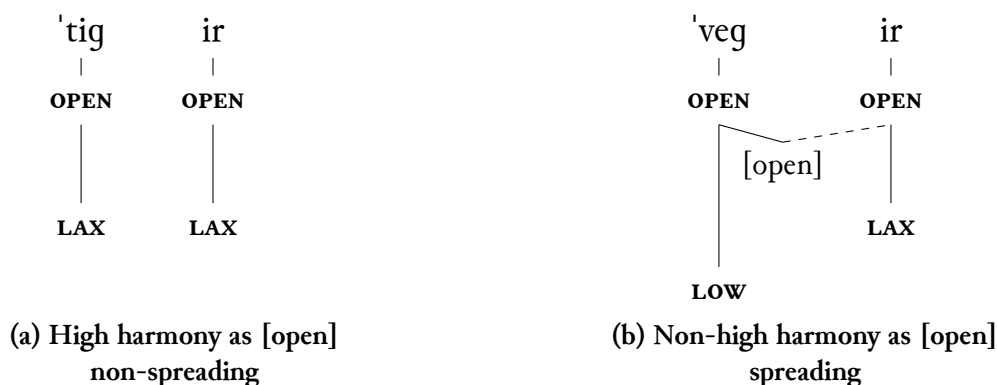


[open] should be associated with [open] where possible. I assume an unstressed vowel may satisfy this rule by being specified for [open] or by local [open]-spreading.

- (124) LICENSE(\check{V} -OPEN, [open]):
 ‘Unstressed vowels which are contrastive for [open] should be associated with [open]’

The licensing principle in (124) captures the basic insight of stress-dependent vowel height harmony via vowel lowering. Specifically, this principle dictates that unstressed contrastively non-open vowels such as /i/ are ‘needy’ in the sense of Nevins (2010) and will seek out [open]-feature specifications to copy from. Where there is no [open]-source, the harmony procedure comes up empty handed and no change occurs – resulting in ‘high’ harmony (125a). On the other hand, if a local [open] feature is available, it spreads – resulting in non-high harmony, as illustrated below in (125b) using data from (112).

- (125) Old Norwegian height harmony as privative [open]-spreading



These examples illustrate how privative [open]-spreading or non-spreading to contrastively non-open /i, u/ inflectional vowels produces high/non-high harmony on the surface. Each new affixed vowel must satisfy the licensing principle in (124), resulting in iterative harmony. The basic mechanisms behind Old Norwegian vowel harmony are thus quite simple and consistent with other typologically common forms of vowel harmony.

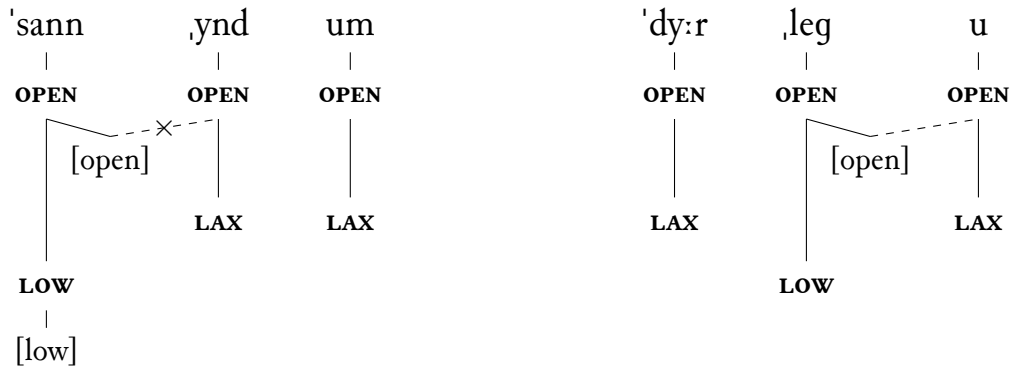
6.3.1 Stressed vowel blocking

According to the LICENSE(\check{V} -OPEN, [open]) principle, only unstressed vowels are ‘needy’, and stressed vowels are therefore inherently non-alternating. Root-initial syllables are stressed in Old Norwegian, and this positional restriction on harmony means [open] does not spread across root-boundaries (e.g. in compounds) or to stressed derivational suffixes – producing the class I–II division in harmonising/non-harmonising suffixes in (126), repeated from (98).

(126) **Harmonising and non-harmonising derivational suffixes**

a.	/sy:t-ing-um/	['sy:t-ing-um]	<fytingum>	'wailing' (wail+SUBS.)-DAT.PL.
b.	/gø:l-ing-um/	['gø:l-eng-om]	<gølengom>	'fondling' (soothe+SUBS.)-DAT.PL.
c.	/sann-,ynd-um/	['sann-,ynd-um]	<fannyndum>	'truth' (true+SUBS.)-DAT.PL.
d.	/dy:r-,leg-u/	['dy:r-,leg-o]	<dyrlego>	'glorious' (glory+ADJ.)-DAT.N.SG.

Class I suffixes are unstressed and are therefore harmony targets – e.g. /-ing-/ in ['gølengom]. In comparison, class II suffixes are stressed and therefore non-alternating according to the harmony principle in (124) – e.g. /-,ynd-/ or /-,leg-/ in ['sann,yndum] and ['dy:r,lego], respectively. Class II suffixes which are specified [open] act as [open]-feature donors to following unstressed harmony recipients. These patterns are illustrated below in (127).

(127) **Stressed neutral/harmonic blocking: ['sann,yndum] and ['dy:r,lego]**

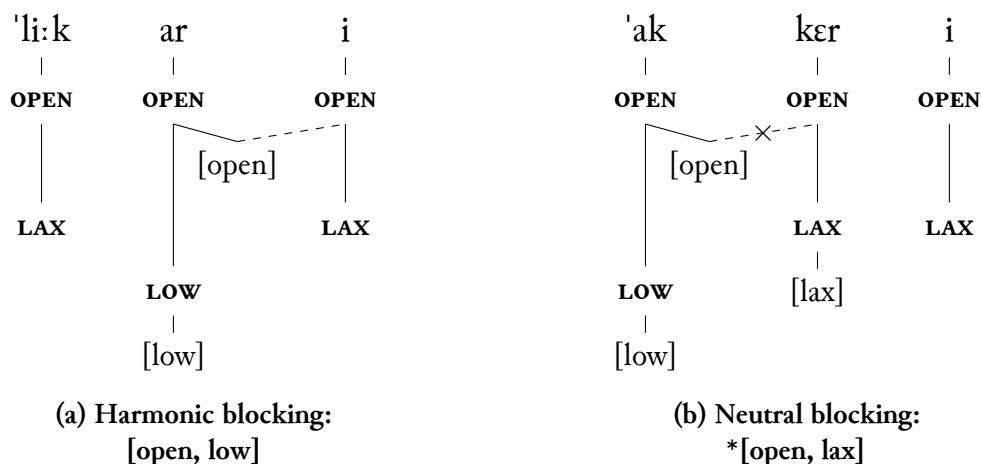
The differences in stress patterns in class I–II harmonising/non-harmonising suffixes is independently motivated by etymologically related derivational suffixes in Modern Icelandic, which exhibit similar stress-based effects on patterns of preaspiration/occlusion outlined in section 5.5.2. The above examples illustrate how asymmetries in [open]-specifications and stressed/unstressed [open]-licensing provide a simple, principled account of apparent exceptional/variable behaviour of derivational suffixes in Old Norwegian height harmony.

6.3.2 **Neutral and harmonic blocking**

According to the contrastive hierarchy method, inventory asymmetries imply feature co-occurrence restrictions, either obligatory [F, G] or prohibited *[F, H] co-occurrence. As shown in section 6.2, Old Norwegian prohibits *[open, lax] and requires [open, low] co-occurrence. This means that Old Norwegian does not permit any *[(open), lax] /ε, ɪ/ or [(open), low] /a, ɐ/ contrast. Given these feature co-occurrence restrictions, applying the Old Norwegian harmony licensing principle in (124) to these [low] and [lax] asymmetric contrasts produces interesting effects. Namely, any underlying [low] vowel must be specified [open]. This restriction motivates harmonic blocking, as illustrated in ['li:k-ar-e] 'likely'-COMP.-NOM.F.SG. in (128a) below. Since the licensing principle is defined over harmony-recipients, harmony spreads from both stressed and unstressed

syllables alike in Old Norwegian. That is, unstressed non-open syllables are harmony-recipients, and [open]-segments are harmony-donors irrespective of their position.

(128) **Feature co-occurrence restrictions and harmonic and neutral blocking**



Second, any unstressed [lax]-vowel is contrastively non-open and therefore should require harmony, but spreading harmony to [lax] vowels would produce a non-permitted *[open, lax] output. This co-occurrence restriction therefore motivates neutral blocking. In other words, [lax] vowels are prohibited [open]-harmony recipients, resulting in no harmonic lowering in ['akkeri] 'anchor'-ACC.SG. in (128b) above. Despite the fact that /ε, ɔ/ vowels cannot undergo harmony, they are nevertheless contrastively non-specified for **OPEN**. Other potential harmony recipients (e.g. /i/ in /'akkeri/) therefore cannot 'see' past /ε, ɔ/ to copy from other potential harmony feature donors further downstream, resulting in blocked harmony (i.e. ['akkeri], not *['akkere]).

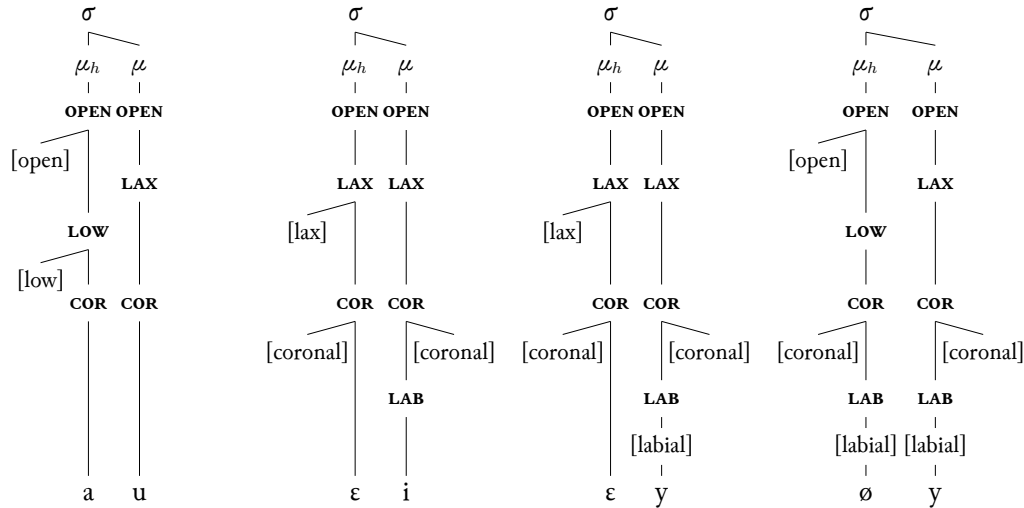
As illustrated in (128), the representational architecture which defines Old Norwegian asymmetric contrasts also naturally produces each vowel's respective harmony behaviour as a side-effect. [low] vowels satisfy LICENSE(\check{V} -**OPEN**, [open]) by (necessarily) being underlyingly specified [open], and unstressed [lax] vowels – though contrastively non-specified for [open] and therefore theoretically 'needy' – cannot satisfy the harmony licensing principle since doing so would produce an illicit *[open, lax] output. In contrast to previous analyses of Old Norwegian and neutral blocking among harmony languages in general, this analysis requires no additional ad hoc machinery or mechanisms to capture such basic blocking effects. These vowels' harmony neutrality is predictable given the size and shape of the Old Norwegian vowel inventory.

6.3.3 Diphthongal non-harmony

Old Norwegian diphthongs are somewhat exceptional in not triggering vowel harmony, even though they may include an [open]-specified element (e.g. ['dauð-ir] and not *['dauð-er] or *['daoð-er] 'dead'-M.NOM.PL.). These patterns receive a straightforward explanation given the above representational generalisations. Old Norwegian diphthongs are bimoraic, as evidenced by Old Norse poetic metrics in which they count as long vowels

(Kristján Árnason 2000) and therefore only occur in stressed syllables. Old Norwegian diphthongs may therefore be understood as two vocalic segments on separate moraic tiers, represented as in (129) following the contrastive hierarchy in Fig. 6.5. Across Old Norwegian dialects, there is variation in the rounding of the /ey/ vs. /øy/ diphthong, further discussed in section 5.1.3. For the sake of illustration, both are included below.

(129) The representation of Old Norwegian [au, ei, ey, øy] diphthongs



As shown above, Old Norwegian diphthongs display an asymmetry in that the nuclear element of the diphthong contains more complex structure than non-nuclear elements – containing [open], [low], and [lax] /a, ε, ø/ vowels while the non-nuclear component permits only less featurally marked high [i, y, u] vowels with only narrowest [coronal] and [labial] feature specifications. The second vocalic element consists of potential harmony targets /i, y, u/, but they do not undergo vowel harmony; that is, a fully [open]-diphthong such as [ao] is not allowed. These generalisations may be interpreted as an example of cross-linguistically common head-dependent asymmetries (Dresher & van der Hulst 1998); that is, in Old Norwegian only head morae (μ_h) license higher-scope feature specifications (e.g. [open], [low], and [lax]) whereas non-head morae license only lower-scope [coronal] and [labial] specifications (129). Under this interpretation, diphthongs are prohibited from undergoing and spreading harmony since doing so would produce complex dependent-morae. This restriction effectively motivates neutrally blocked height harmony ['dauð-ir] and not height harmonic *['daoð-er].

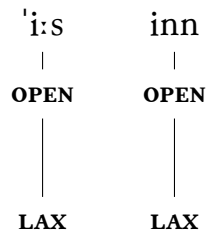
6.3.4 (Non-)exceptional definite enclitics

In section 5.7, we explored the considerably complex surface patterns of Old Norwegian definite enclitics. First, we confirmed that there is dialectal variation in the shape of the definite enclitic. Specifically, the DG8 manuscript displays the exceptionally non-alternating definite enclitic /-en-/ in contrast to the corresponding, regularly harmonising /-in-/ definite enclitic in the H6 manuscript. Following this analysis, /-en-/ in DG8 is specified [open], and the explanation of its apparently exceptional character thus does not

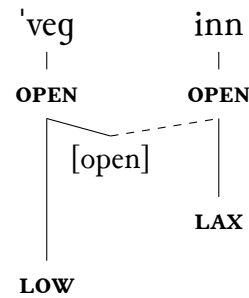
require any additional machinery. /-en-/ is already associated with the harmony feature and therefore satisfies LICENSE(\check{V} -OPEN, [open]) by its underlying [open] specification. This pre-specification for the harmony feature correctly predicts that such suffixes will display no harmony alternations. In comparison, the underlyingly non-open /-in-/ definite enclitic in the H6 manuscript is predicted to behave like other unstressed non-open suffixes and undergo harmony. This dialectal difference between the DG8/H6 scribes is illustrated using open/non-open examples of the DEF.-ACC.M.SG. [-in-n]/[-en-n] suffix in /'i:s-/ 'ice' and /'veg-/ 'way' in (I30).

(I30) Non-/open definite enclitics in H6 and DG8

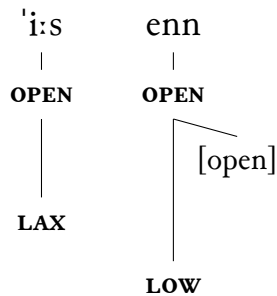
(a) H6 ['i:s-in-n]



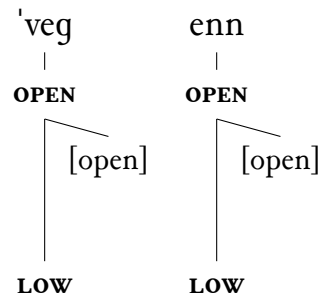
(b) H6 ['veg-en-n]



(c) DG8 ['i:s-en-n]



(d) DG8 ['veg-en-n]



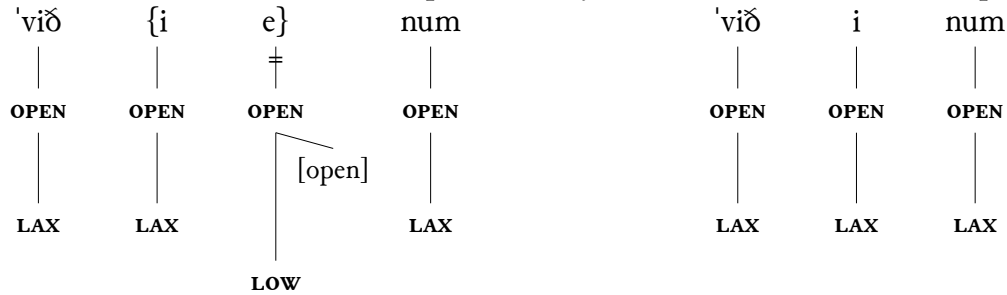
The privative nature of the harmony feature naturally produces the [open]/non-open asymmetry between non-harmonising [open] /-en-/ in DG8 and harmonising, non-open /-in-/ suffix in H6: e.g. /'i:s-in-n/ → ['i:sinn] but /'veg-in-n/ → ['vegenn] 'way'-DEF.ACC.M.SG. Secondly, since Old Norwegian height harmony is prosodically sensitive, being restricted to unstressed syllables, the definite enclitic /-en-/ in DG8 does not trigger regressive harmony on the preceding syllable – i.e. /'i:s-en-n/ → ['i:senn], not *['e:senn].

6.3.5 Vowel harmony and vowel deletions

The preceding definite enclitic harmony patterns are quite simple but are significantly complicated by intervening vowel deletions, which occur in certain vowel hiatuses, as outlined in section 5.7.2. This process is summarised derivationally in two steps below in (I31) using the DG8 definite enclitic /-en-/ attached to the high-vowel noun /'við-/ 'wood' as an example. First, the DAT.SG. suffix /-i-/ is attached to the root and harmonises.

Given that there is no [open]-source to copy from, the vowel surfaces as high: /við-i/ → [viði] ‘wood’-DAT.SG. Second, a vowel hiatus is created when the definite enclitic /-en/ is suffixed to the vowel-final form [viði]. In such environments, the definite enclitic’s vowel is deleted, leaving the following DAT.M.SG. /-um/ suffix to harmonise with the preceding high vowel in [viði]. Unlike the disharmonic [i:s-en-n] example in (130c) above, the potential [open]-donor vowel in /-en-/ is deleted (131) – meaning that such eliding environments are always height harmonic in Old Norwegian, as illustrated in (131b).

(131) Vowel deletion and non-open harmony in DG8 [viðinum] in two steps

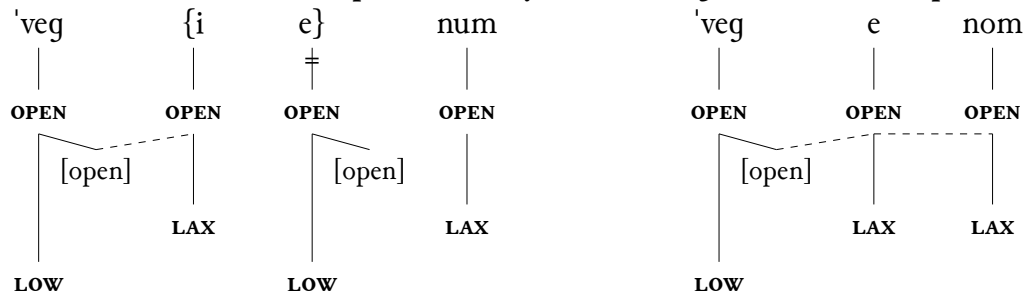


(a) Vowel hiatus triggers vowel deletion

(b) Non-elided inflectional vowels harmonise

The derivations in (131) illustrate high vowel harmony in eliding contexts. The corresponding patterns following an [open]-root in DG8 – e.g. /veg-/ ‘way’ – is a bit more complex, as summarised below in (132). First, the DAT.SG. suffix is attached and harmonises /veg-i/ → [vege] ‘way’-DAT.SG. Second, the affixation of the definite suffix creates a vowel hiatus, /veg-{e-e}n, which triggers vowel deletion. Third, the final inflectional suffix /-um/ harmonises to preceding [open]-vowels: /veg-e-n-um/ → [vegenom].

(132) Vowel deletion and [open]-harmony in DG8 [vegenom] in two steps



(a) Affixed suffix harmonises; second suffix creates a hiatus, triggering vowel deletion

(b) Non-elided inflectional vowel harmonises

This analysis demonstrates that the relatively complex and only partially harmonising patterns of the definite enclitic outlined in section 5.7 can be quite simply understood as dialectal variation in [open]-specification of the definite suffix /-in, -en/ and the combined effect of vowel deletions and overlapping harmonisation. These simple components produce the diverse but entirely systematic exceptional harmony patterns of Old Norwegian definite forms.

6.4 Implications for other sound patterns

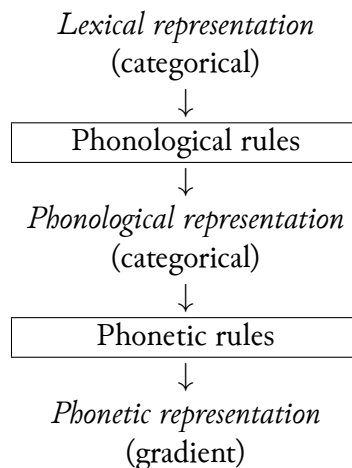
Old Norwegian vowel harmony interacts with a number of other sound processes, in particular *j*-, *i*-, and *u*-umlauts, previously discussed in section 5.6. As shown below in the data in (133), repeated from (100), *j*-umlaut palatalises an immediately following back vowel (e.g. /ja/→[jæ]), *i*-umlaut fronts an /a/→[ɛ] before a following /i/, and *u*-umlaut rounds /a/→[ɔ] before a following /u/. Height harmony overlaps with *j*-umlaut (133ab) but is bled by *i*- and *u*-umlaut (133c–f).

(133) **Overlapping height harmony and *j*-, *i*-, and *u*-umlaut**

a.	/ˈfjarri/	→	[ˈfjærre]	<fiærre, fiarre>	‘far off’ ADV.
b.	/ˈgjaf-ir/	→	[ˈgjæv-er]	<giæver, giaver>	‘gift’-ACC.PL.
c.	/ˈhaf-ir/	→	[ˈhæv-ir]	<hævir, hevir>	‘have’-PRES.3.SG.INDIC.
d.	/ˈgang-it/	→	[ˈgɛng-it]	<gængit, gengit>	‘walk’-PRET.PART.
e.	/ˈbarn-um/	→	[ˈbɔrn-um]	<barnum, bornum>	‘child’-DAT.PL.
f.	/ˈland-um/	→	[ˈlɔnd-um]	<landum, londum>	‘land’-DAT.PL.

In previous sections, we have not given much consideration as to what kind of process these umlauts are. In phonology in general and historical phonology in particular, establishing the status of a given sound process is not trivial. Among sound processes, structuralist and generative theories of phonology assume a basic division between phonological and phonetic rules, as illustrated by the individual modules in Fig. 6.14, adapted from Bermúdez-Otero (2007, p. 502).

Figure 6.14: The classic modular feedforward model of phonology



Phonetically categorical sound patterns are symptomatic of phonological (lexical/post-lexical) rules since such patterns result from the manipulation of categorical phonological objects such as discrete features. Whether a sound pattern’s distribution is categorical or gradient is therefore a commonly used criterion for determining its phonological or phonetic status. However, even when aided by acoustic analysis, a pattern’s categoricity or gradience is not always obvious (Iosad 2017b, Strycharczuk 2012), and this problem is exacerbated in medieval orthography where non-normalised spelling variation may confound the patterning of certain sound processes. For example, how do we determine

how gradient a pattern is in written texts, which are necessarily represented in discrete, categorical letters? And vice versa, how consistent do spelling patterns need to be to evidence phonetic categoricity? These questions can be considerably complicated by a language's orthography. For example, as we saw in sections 5.1.1/5.1.2, *i*- and *u*-umlaut patterns are represented considerably inconsistently within and across 13th-century Norwegian scribes, but this is not sufficient evidence to conclude that these umlaut patterns were phonetically gradient. Old Norwegian orthography simply has no unique letter with which to represent *i*- and *u*-umlaut-product vowels [ɛ, ɔ]. With no corresponding letters, [ɛ, ɔ] are commonly, variably spelled using one of the neighbouring [e, æ] and [o, a] vowels' letters, respectively. How categorical or inconsistent a sound pattern's spelling is in historical texts is thus not a very reliable criterion for establishing the status of historical sound patterns.

Iosad (2017b) has shown that the phonological status of a pattern is better established by reference to criteria of *modularity*. A modular approach to grammar as in Fig. 6.14 sets non-trivial restrictions on the division of labour in the language faculty and thereby limits the possible set of interactions (Scheer 2010, Bermúdez-Otero 2012). It follows from this that certain linguistic objects are 'proprietary to their module': e.g. only processes in the phonological module may refer to specifically phonological entities such as featural specifications, metrical constituency, and so on. Furthermore, it follows from this that successive modules may not refer to the objects of preceding modules: e.g. processes in the phonological module *may not* refer to morphosyntactic information. Modularity therefore serves as an explicit criterion for establishing or ruling out the phonological status of a given sound process; 'if a pattern makes crucial reference to such proprietary phonological information, it must also be phonological, because only computation inside the phonological module can access such phonology-internal information' (Iosad 2017b, p. 4). We can use these criteria to disambiguate the status of Old Norwegian vocalic patterns.

6.4.1 The status of Old Norwegian height harmony and *u*-umlaut

The phonological status of vowel harmony in the (pre-harmony decay) DG8/H6 manuscripts is non-controversial. Height harmony in these manuscripts displays categorical orthographic correspondence for the feature [open] and applies at the word-level, as evidenced by iteratively harmonising derivational and inflectional suffixes. According to modular criteria therefore, pre-decay stages of Old Norwegian vowel harmony are clearly phonological since harmony makes crucial reference to principally phonological information (i.e. the feature [open]), resulting in height correspondence across the prosodic word. Vowel harmony provides crucial relative evidence for discerning the status of umlaut processes with which it interacts. Let us begin by exploring the relationship between height harmony and *u*-umlaut patterns.

Descriptively, *u*-umlaut involves the rounding of /a/ to [ɔ] before a subsequent /u/, but the status of *u*-umlaut is one of the most contested problems in Nordic phonology. At the outset, it is not clear whether *u*-umlaut is a form of assimilation (and if so, what kind) or non-phonological allomorphy (and if so, what kind). The main focus of this debate in Norse phonology has been on corresponding *u*-umlaut patterns in Modern/Old Icelandic and Faroese. The corresponding patterns in Old Norwegian have played little

to no role in this debate, but the interaction between Old Norwegian vowel harmony and *u*-umlaut provides some novel, previously overlooked evidence which sheds new light on this problem. In the following section, I show that the non-transparent interaction between *u*-umlaut and height harmony suggests *u*-umlaut represents a morphophonemic rule which triggers [open, low] [a] ~ [lax] [ɔ] allomorphy before a following historical **u*-morpheme.

Historically, in Proto-Norse, *u*-umlaut consisted of anticipatory rounding of non-round /i, e, a/ vowels before a subsequent *u* or *w* to [y, ø, ɔ].⁵ At this early stage, it is agreed among Norse philologists that *u*-umlaut represented a phonologically regular assimilatory or harmony process since it applied equally to all non-round vowels. However, in Late Proto-Norse, the apocope of *u*-umlaut-trigger *-*u* suffixes led to the secondary split of round/non-round [a] and [ɔ] allophones into distinct phonemes. This evidences that *u*-umlaut effects had been lexicalised prior to the loss of *u*-umlaut triggers.

In later stages of Norse languages, the patterning of *u*-umlaut changes considerably; only short /a/ continues to undergo *u*-umlaut alternations (e.g. Old Norwegian [ʼall-er] but [ʼɔll-um] ‘all’-NOM./DAT.PL.). Other historically *u*-umlauting vowels have ceased to alternate: e.g. [ʼfisk-ar] and [ʼfisk-um], not umlauted *[ʼfysk-um] ‘fish’-NOM./DAT.PL.). Over time, the *u*-umlaut process admits an increasing number of exceptions or restrictions. For example, while common in Modern Icelandic, *u*-umlaut is no longer surface true but morpheme-specific: e.g. *u*-umlauted ‘day’-DAT.PL. *dög-um* vs. non-umlauted NOM.SG. *dag-ur*. Nevertheless, the patterning of *u*-umlaut, though highly restricted, still closely resembles its historical distribution. /a/ rounds before (the majority) of *u*-suffixes and behaves therefore by and large like an assimilatory process. It has therefore been debated what post-Proto-Norse *u*-umlaut is, which has ‘come to occupy the misty and lawless borderlands between phonology and morphology, spurring debate about whether it is still “productive”, “phonological”, or even a “process” in any meaningful sense’ (Gunnar Hansson 2013).

The interaction between *u*-umlaut and vowel height harmony in Old Norwegian provides new evidence against the status of *u*-umlaut as a phonological pattern. Though both *u*-umlaut and height harmony apply at the word-levels (targeting or being triggered by inflectional/derivational suffixes), these processes interact non-transparently. *U*-umlaut derives a harmonically neutral [ɔ] from a potential harmony trigger /a/ (e.g. /all-um/ → [ɔllum] ‘all’-DAT.PL.), thereby bleeding height harmony. In other words, it is crucial that height harmony applies to the output of *u*-umlaut, and this ordered relationship demonstrates that the two processes operate in separate modules.

This state of affairs receives a straightforward explanation according to the life-cycle of phonological processes, according to which sound patterns develop over a long time from gradient phonetic patterns to categorical rules applying in ever narrowing morphosyntactic domains (Bermúdez-Otero & Trousdale 2012; Bermúdez-Otero 2007, 2015). The relative chronology of the development of Old Norwegian *u*-umlaut, height harmony, and the secondary split of /a/ and /ɔ/ is illustrated in sequential stages in Fig. 6.15. See Bermúdez-Otero (2007) for a similar analysis and illustration of the Sanskrit Law of Palatals (Fox 1995, pp. 27–29).

⁵See Haugen (2012) for a useful overview of the historical development of *u*-umlaut down to Old Norse, including reconstructed Proto-Norse paradigms.

Figure 6.15: The life-cycle of Old Norwegian *u*-umlaut and height harmony

	1	2	3	4	5
<i>Lexicon</i>	/a/	/a/	/a/	/a/	/a/ ≠ /ɔ/
<i>Phonological rules</i>			<i>u</i> -umlaut	<i>u</i> -umlaut	harmony
<i>Phonetic rules</i>		<i>u</i> -umlaut		harmony	

Early Proto-Norse (stage 1 in Fig. 6.15) displayed neither *u*-umlaut or height harmony. We may assume that both *u*-umlaut and height harmony entered the language as gradient, phonetic rules – evolving out of natural co-articulation (Ohala 1994). For *u*-umlaut, this occurred at stage 2. However, when chronologically younger height harmony entered the phonetic component at stage 4, *u*-umlaut had already been stabilised (in the sense of Bermúdez-Otero 2007) as a categorical phonological rule (stage 3). Once height harmony had been stabilised in the form we find it in the DG8/H6 harmony manuscripts as a categorical, phonological rule (stage 5), *u*-umlaut had already been lexicalised, preceding the secondary split of [a, ɔ] allophones into distinct /a/ and /ɔ/ phonemes. This is evidenced by morphological *u*-umlaut which marks the nominative/accusative plural in the neuter nouns in (134) – corresponding to historically apocopated plural **u*-suffixes: e.g. [lɔnd] < *land-*u* ‘land’-NOM.PL.

(134) ***u*-umlaut plural marking in Old Norwegian**

- | | | | | | | |
|----|---------|---------|---|--------|----------------|--------------------|
| a. | /land/ | [land] | ~ | [lɔnd] | <land, lond> | ‘land’-SG./PL. |
| b. | /barn/ | [barn] | ~ | [bɔrn] | <barn, born> | ‘child’-SG./PL. |
| c. | /hærað/ | [hærað] | ~ | [hæɔð] | <hærað, hæroð> | ‘district’-SG./PL. |

Morphological *u*-umlaut in (134) demonstrates that the allophones [a] and [ɔ] had become discrete phonological categories (so-called ‘quasi-phonemes’; Janda 1999) prior to the apocope of historical **-u* suffixes. It is in other words no longer a productive phonological assimilatory process. In Old Norwegian, *u*-umlaut represents a morphophonemic rule deriving /a/ → [ɔ] before historical **u*-morphemes, which captures both purely morphological [lɔnd] and semi-phonological [lɔnd-um] umlaut types.

6.4.2 Parallel morphophonemic patterning in *i*-umlaut

This characterisation of *u*-umlaut has clear parallels in other (non-controversially non-phonological) historical remnants of Proto-Norse umlaut, e.g. *i*-umlaut alternations outlined below in (135). This parallel patterning suggests that both *i*- and *u*-umlaut are products of the same kind of morphophonemic rule deriving [a, ɛ, ɔ] alternations which bleed height harmony.

Like English *man* vs. *men*, the Nordic languages display limited remnants of *i*-umlaut alternations. Let us focus on low, short vowel alternations: e.g. Old Norwegian [‘hav-a] vs. [‘hev-ir] ‘have’-INF./PRES.3.SG.INDIC. As these examples illustrate, like *u*-umlaut ([a, ɔ]) alternations, *i*-umlaut involves alternations between a harmonic [a] and harmonically neutral [ɛ] vowel. The distribution of *i*-umlaut therefore has interesting effects on Old Norwegian vowel harmony patterns, as illustrated in (135) below.

(135) Morpheme-specific height harmony – *i*-umlaut interactions

		/-i/ SUBJ.	/-ir/ INDIC.
a.	/lif-/ ‘live’	[liv-i] <liv-i>	[liv-ir] <livir>
b.	/ger-/ ‘do’	[ger-e] <gere>	[ger-er] <gerer>
c.	/haf-/ ‘have’	[hav-e] <have>	[hæv-ir] <hævir>

In (135ab), we observe that both subjunctive and indicative suffixes /-i, -ir/ in Old Norwegian share the synchronic phonological property that they are both active harmony targets, alternating with [open] [e]; compare high [liv-i/-ir] vs. non-high [ger-e/-er]. However, when attached to a [low] /a/ root, the suffixes display differing patterns, which are not predictable from their phonological shape. The indicative suffix /-ir/ < Proto-Norse **iþ* triggers *i*-umlaut root-allomorphy in Old Norwegian: **haf-iþ* > [hæv-ir], thereby bleeding height harmony (**[hev-er]*), but the subjunctive suffix /-i/ does not trigger umlaut. The subjunctive suffix was historically a non-high **ē* in Proto-Norse which later underwent raising and in Old Norwegian functions as a fully regular harmony target: i.e. **haf-ē* > **haf-i* > [hav-e]. The *i*-umlaut patterns are thus not surface true; they are fossils of Proto-Norse vowel distributions and interact non-transparently with Old Norwegian height harmony.

The *i*-umlaut alternations in Old Norwegian in (135) are thus very similar to *u*-umlaut. First, *i*-umlaut is triggered specifically by a short, non-initial /i/ and derives [a, ε] alternations which bleed height harmony. Second, all suffixes which historically triggered *i*-umlaut in Proto-Norse, still result in [a, ε] alternations in Old Norwegian. The only significant difference is that later **ē* raising has produced minimal non-/umlauting /i/ contrasts – demonstrating that *i*-umlaut is morpheme-specific in Old Norwegian.

Old Norwegian umlaut patterns have close parallels in Modern Icelandic, and I suggest they can be largely analysed in the same way.⁶ Modern Icelandic differs from Old Norwegian in that it later underwent a process of *u*-epenthesis (phonetically transcribed as [ʏ]). Like historically raised **ē* suffixes which fail to trigger *i*-umlaut, historically epenthised suffixes do not trigger *u*-umlaut in Icelandic – showing that this process is now morpheme-specific like *i*-umlaut. For example, consider the non-umlauting (historically epenthised) NOM.M.SG. suffix *-ur* [-ʏr] in ‘day’ [daɣ-ʏr] < **dag-r* (not umlauted **[dœɣ-ʏr]*) in contrast to umlauting (historically non-epenthised) *u*-morphemes such as the DAT.PL. *-um* [-ym] (e.g. [dœɣ-ym], **[daɣ-ym]* < **dag-um*). Like the division between umlauting and non-umlauting *i*-morphemes in Old Norwegian in

⁶As a result of various mergers and vocalic changes, the phonetic realisation of Icelandic *u*-umlaut is today /a/ → [œ]/[___ɣ]. There are additionally finer differences between Old Norwegian and Modern Icelandic in whether *u*-umlaut is iterative or not and what the realisation of *u*-umlaut is in stressed and unstressed positions, as in Icelandic (e.g. /kast-að-u/ → [ˈkœstuðu] ‘throw’-PRET.-3.PL.) vs. Old Norwegian (/kast-að-u/ → [ˈkæstðu]), but the patterning of *u*-umlaut is otherwise essentially the same as in Old Norwegian. See Kristján Árnason (2011, ch. 11) for a more detailed overview of the Icelandic patterns.

(135), Icelandic therefore displays parallel umlauting and non-umlauting *i* and *u* suffixes, as illustrated in (136).⁷

(136) **Morpheme-specific umlauts in Modern Icelandic ‘have, day’ inflections**

/-i/ SUBJ.	/-ir/ INDIC.	/-yr/ NOM.SG.	/-ym/ DAT.PL.
[hav-i]	[hæv-ir]	[day-yr]	[dœy-ym]
<i>hafi</i>	<i>befir</i>	<i>dagur</i>	<i>dögum</i>

In summary, the non-transparent interaction between Old Norwegian vowel height harmony and *i*- and *u*-umlaut patterns suggest that these umlauts are not phonological but morphophonemic. Even though Modern Icelandic lacks the corresponding vowel harmony evidence, the distribution of Icelandic *i*- and *u*-umlaut suggests that it is amenable to the same kind of analysis. *I*- and *u*-umlaut are morphophonemic rules which produce [a] ~ [ɛ] and [a] ~ [ɔ] allomorphy in Old Norwegian and [a] ~ [ɛ] and [a] ~ [œ] allomorphy in Modern Icelandic.

6.4.3 *J*-umlaut and height harmony

The patterning of *j*-umlaut is distinct from other umlaut processes. The application of *j*-umlaut is inconsistent, varying between palatalised and non-palatalised <æ, a> (e.g. [‘fjærre]/[‘fjarre] <fiærre, fiarre>). The frequency of *j*-umlaut seems to depend on the environment and/or the lexical item. *j*-umlaut applies most readily following velar consonants in the DG8/H6 manuscripts: e.g. 100% of *gjalda* ‘pay’-INF. are spelled <giældda> whereas only a single instance of *bjartleik* ‘brightness’-ACC.SG. displays *j*-umlaut <biærtleik>.

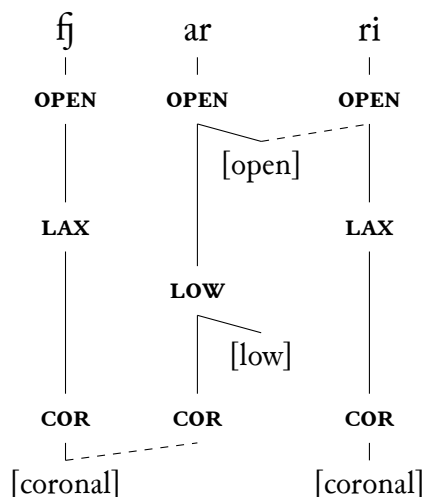
The variable character of *j*-umlaut is not surprising given its young age. According to the philological literature, Norwegian displays examples of *j*-umlaut only since the first half of the 13th century, first in Eastern Norwegian and Trøndersk, and in Western Norwegian from c 1300 on (Seip 1955, pp. 122–23, 246). This is thus an innovative process in our current 13th-century corpus. I interpret the orthographic patterns of *j*-umlaut as reflecting post-lexical palatalisation at this stage of the language – that is, phonological palatalisation but which is optional. Consistent with this assumption, *j*-umlaut interacts transparently with height harmony: e.g. a form like [‘fjærre] is both palatalised and height harmonised.

⁷Some phonologists attempt to get around the problem of non-umlauting, epenthesis suffixes by treating *u*-epenthesis as synchronically active in Modern Icelandic. In this way, epenthesis (non-umlauting) suffixes could be construed as lacking the underlying *u*-umlaut trigger vowel /y/ in contrast to non-epenthesis suffixes (e.g. /-r/ vs. /-ym/; cf. Gibson & Ringen 2000). But such synchronic treatments are not tenable as the process of epenthesis is historical and not surface true – at least since the 17th century – as evidenced by the modern /-r, -yr/ and /-s, -ys/ minimal pairs in (iii), provided by Anton Karl Ingason (2013).

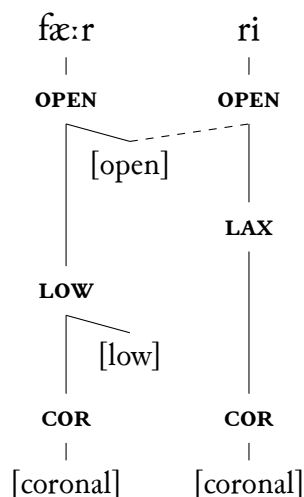
(iii) **/-r, -yr/ and /-s, -ys/ minimal pairs in Modern Icelandic**

- | | | | |
|----|-----------|----------------|-----------------------------|
| a. | [flœ:yr] | <i>flögr</i> | ‘flying’-NOM.SG. (deverbal) |
| b. | [flœ:yr] | <i>flögur</i> | ‘chips, snacks’-NOM.PL. |
| c. | [r̥apnys] | <i>Hrafnus</i> | ‘Hrafn (nickname)’-NOM. |
| d. | [r̥apns] | <i>Hrafn</i> | ‘Hrafn’-GEN. |

(137) *j*-umlaut and height harmony derive harmonic [æ]: ['fjærre], ['fæ:rre]



(a) Derived [æ] height harmony



(b) Non-derived [æ:] height harmony

Traditionally it has been assumed that the product of *j*-umlaut and chronologically much older *i*-umlaut are identical (cf. Seip 1955, pp. 119–23). As discussed previously in section 5.6, the distinct orthographic and phonological patterning of *j*- and *i*-umlaut products suggest this is not the case. The product of *j*-umlaut is always represented <æ> and is always height harmonic, orthographically and phonologically like its long counterpart [æ:]–<æ> (e.g. ['fæ:r-re] <færre> 'few'-COMP.). This suggests therefore that *j*-umlaut simply spreads [coronal] to [open, low] /a/, deriving [open, low, coronal] [æ], as illustrated in (137). In comparison, the product of chronologically much older *i*-umlaut displays <æ, e> spelling variation and interacts non-transparently with height harmony: e.g. a form like ['hævur] is palatalised but height disharmonic – phonologically and orthographically identical to non-derived [lax, coronal] [ɛ] (cf. ['hæll-um] <hællum, hellum> 'cave'-DAT.PL.). Differing in both orthographic and phonological behaviour, the product vowels of *j*- and *i*-umlaut are clearly distinct.

6.5 Conclusions

Old Norwegian displays a very complex vowel inventory with multiple kinds of asymmetries which are revealed in interesting ways in the patterning of vowel harmony and umlaut processes. The Correlate Contrastivist Hypothesis, defined in (32), states that phonological regularities in surface contrasts and alternations in a language inform phonological representations. Following this hypothesis, I have shown in section 6.2 how we can infer Old Norwegian's vocalic features and feature co-occurrences in a straightforward way using phonological contrasts and alternations in Old Norwegian vowel orthography. According to the contrastive hierarchy method, these representational deductions imply a simple vowel harmony grammar, which I have shown provides an accurate and insightful analysis of the complex blocking patterns observed in Old Norwegian vowel height harmony.

Old Norwegian displays prosodically sensitive, vowel height harmony via vowel lowering; structurally very similar to common types of Bantu height harmony. As we have seen in section 6.3, Old Norwegian vowel harmony can be easily accommodated using a licensing approach which requires unstressed, non-open vowels to be associated with [open]. Old Norwegian height harmony is non-parasitic – that is, height correspondence is not dependent on trigger/target agreement for some orthogonal feature – indicating that the harmony feature [open] has broadest scope. Old Norwegian displays multiple classes of neutral (non-alternating) segments which are unpaired for the harmony feature; these include [ɛ, ɔ] and [æ, æ:, a, a:], which are neutral and harmonic blocking, respectively. In this chapter, I have demonstrated how these blocking behaviours follow in a straightforward way from inventory-asymmetry-defining prohibited *[open, lax] and obligatory [open, low] co-occurrence constraints. This approach provides a principled and economical account of both Old Norwegian vowel representations and vowel harmony. Building on these results, in section 6.4 I have provided a more detailed analysis of how Old Norwegian height harmony interacts with other processes (vowel deletions and *j*-, *u*-, and *i*-umlauts) – producing complex but highly systematic surface harmony and neutral harmony patterns.

This analysis provides an illuminating and typologically-coherent solution to the Old Norwegian riddle. Harmony blocking patterns in Old Norwegian are predictable effects of limitations on the distribution of [open]-contrasts among [low] and [lax] vowels. This investigation provides a detailed illustration of how the Correlate Contrastivist Hypothesis provides an explicit methodology for interpreting historical phonological representations from regular phonological generalisations evidenced in textual material. This theoretically-informed corpus investigation demonstrates the value of philological study at securing detailed, reliable phonological data and makes a novel contribution to the typology of vowel harmony. Though all the components of Old Norwegian height harmony are individually attested cross-linguistically, their unique combination and rare interaction with other morpho/phonological phenomena in Old Norwegian makes for a highly significant and rare specimen among harmony languages. This investigation of Old Norwegian sound patterns demonstrates the important value philology can still play in informing theoretical linguistics and language typology.

Part IV

Conclusions

Chapter 7

Summary and conclusions

In this thesis I have offered a novel approach to the acquisition and representation of phonological features and segments using Contrastive Hierarchy Theory and pursued its implications for the nature and patterning of harmony processes in detail. Guided by this framework, I have provided a thorough corpus study and analysis of Old Norwegian vowels and vowel harmony, which have previously defied a coherent analysis. I have identified important parallels in the vowel patterns of Old Norwegian and other harmony languages, and I have shown how their typology receives a unified, principled account following the contrastive hierarchy method.

This analysis supplies insightful and cross-linguistically consistent solutions to the riddles this thesis began with. The typology of blocking patterns in Old Norwegian and other languages' assimilatory processes can be understood as predictable, emergent effects of representational limitations captured by a contrastive hierarchy approach which incorporates privative, emergent features and feature-nodes. The combination of these broad typological and narrow empirical studies demonstrate the viability of this framework to provide new theoretical insights on old and new problems.

In this final chapter, I give a summary of the important components of this theory and a practical illustration of the way it may be applied to new data. Using a phonological adaption of Westergaard's (2009, 2013, 2014) model of micro-cues, I advocate an explicit bottom-up approach to the emergence and acquisition of phonological features when parsing linguistic input. This is reviewed in section 7.1 using Yoruba (Atlantic-Congo) vowel patterns as a practical example. Feature class and subclass relationships in phonological patterns demonstrate hierarchical organisation of phonological features, which I capture using the Successive Division Algorithm (SDA), illustrated in section 7.2. The SDA provides the mechanism by which language learners organise their phonological features into the hierarchical class and subclass relationships relevant to their phonology. The SDA produces a limited range of variation in feature under/specification which makes precise typological predictions regarding segments' activity and visibility with respect to phonological processes. In section 7.2 I show that these predictions are borne out in the observed microvariation in vowel patterns across Yoruba dialects and structurally similar languages. As this cross-linguistic survey illustrates, this representational architecture implies an explicit and economical harmony grammar. In section 7.3, I provide abstract schemas which demonstrate the exact relationship between each commonly attested harmony behaviour type and their specific featural representations – providing a precise

road map for the analysis of new harmony systems. Final concluding remarks and directions for future research are given in section 7.4.

7.1 Acquisition and emergence of sound inventories

I have argued that languages' sound inventories are defined according to what I have called the Correlate Contrastivist Hypothesis, adapted from D. C. Hall (2007, p. 20), which holds that 'the phonemes of a language L are equal to the sum of features and feature co-occurrence restrictions which are minimally necessary for the expression of phonological regularities in L '. I argue that these phonological regularities are expressed using emergent, substance-free features – that is, the content and relationship between features and segments is not fixed, rather features emerge as required by the phonological component to label language-specific contrasts and alternations.

As a model of phonological acquisition, I have adapted certain insights from Westergaard's (2009, 2013, 2014) model of micro-cues. The key idea is that in the course of language acquisition – in order to learn, label, and define contrasting sound classes – speakers posit features and feature co-occurrence restrictions on the basis of observed contrasts in salient phonetic properties, lexical meaning, and phonological behaviour. This approach which advocates that features are posited only when positively evidenced by phonological patterns provides methodical limits on the reference of substance-free features and a principled account of how phonological features emerge.

In the way of a short, practical example, let us consider the vowel patterns in (138), taken from the Ifẹ variety of Yoruba, previously discussed in sections 2.3 and 3.1–3.2. The data in (138) display a number of salient vocalic contrasts and alternations. For simplicity's sake, we will ignore labial (or front/back) contrasts and assume the language displays anticipatory (leftwards) vowel harmony.

(138) Ifẹ Yoruba ATR/RTR harmony (Ọla Oriẹ 2001, 2003)

- | | | | | |
|----|-------|----------------|-------|-------------|
| a. | ebẹ | 'heap of yams' | esẹ | 'foot' |
| b. | igbe | 'noise' | igbẹ | 'excrement' |
| c. | ebi | 'hunger' | èbi | 'guilt' |
| d. | èbúte | 'harbour' | èlùbú | 'yam flour' |

In order to accurately generalise and acquire the vowel patterns in (138), the speaker must observe two distinctions in contrasts and alternations, evidencing two features. First, the alternations and correspondence in advanced and retracted tongue root [e] / [ɛ] in (138a) evidence some [ATR] or [RTR] feature. Second, we must assume a second feature – e.g. [close] or [open] – to distinguish close [i] from non-close [e, ɛ] vowels (138ab). Close vowels are (neutral), non-alternating with respect to tongue root harmony (138bd), co-occurring with both advanced and retracted vowels: e.g. [èlùbú], not *[èlùbú]. This suggests that close vowels are specified for some feature (e.g. [close]) which is incompatible with the harmony feature (i.e. *[close, RTR]). Since close vowels are incompatible with the harmony feature and therefore initiate no harmonisation on preceding segments, close vowels indicate the unmarked/recessive category when in trigger positions (that is, the default or underlying value). In Ifẹ Yoruba, the unmarked value must

therefore be non-RTR since close (neutral) vowels typically take advanced prefixes: e.g. [ebi] ‘hunger’. The active or marked harmony feature is therefore [RTR].

(139) **Generalising Ife Yoruba vocalic representational micro-cues**

	Patterns	Surface generalisations			Micro-cue
a.	εṣɛ̣ eḅɛ̣	[ε] [RTR]	vs. vs.	[e] non-RTR contrasts/harmony	[RTR]
b.	ebi eḅi	[i] [close]	vs. vs.	[e] non-close contrasts	[close]
c.	igbe igḅɛ̣	[i] [close]	vs. vs.	*[I] *[close, RTR] contrasts/harmony	*[close, RTR]

By deduction then, as summarised in (139) above, Ife Yoruba contrasts and phonological alternations imply an [RTR]-harmony pattern with two categories of vowels – [close] /i/ and non-close /ε, e/ – where close vowels are incompatible/non-alternating with respect to the harmony feature (i.e. *[RTR, close]). These patterns evidence in sum two features and one feature co-occurrence restriction: [RTR], [close], and *[RTR, close]. These representational cues define a segment inventory, as illustrated below in Table 7.1; that is, an [RTR]-specified harmony trigger /ε/, a non-RTR (and non-close) harmony target /e/, and a [close]-specified segment /i/, which is prohibited from participating in [RTR]-processes – barring [close] /i/ vs. *[close, RTR] */i/ contrasts.

Table 7.1: Ife Yoruba inventory defined by [RTR], [close], and *[close, RTR] micro-cues

Micro-cues	Phonemes
[RTR]	/ε/
[]	/e/
[close]	/i/
*[close, RTR]	*/i/

This limited example from Ife Yoruba tongue root harmony illustrates how the accurate acquisition of the phonological grammar ensures an accurate generalisation of the relevant segment inventory, demonstrating the direct link between a language’s segmental phonological patterns and its inventory size/shape. Mergers and splits arise diachronically when speakers misidentify important contrasts and/or alternations, leading either to too few or too many representational micro-cues.

7.2 The contrastive hierarchy and feature specifications

The data and discussion above provide a simple example of how phonological activity evidences the number and co-occurrence of inventory-defining phonological features. However, a segment’s activity or inactivity with respect to a phonological pattern

represents only one component of a segment's phonological behaviour. Across Yoruba dialects, we observe that close vowels vary additionally with respect to their visibility to [RTR]-harmony, as summarised in (140) below.

(140) **Variation in Yoruba close vowel activity and visibility to [RTR]-harmony**

- | | | | | |
|----|-------|----------|-----------|------------------------------------|
| a. | èlùbù | active | visible | Ekiti Yoruba – harmonic |
| b. | èlùbù | inactive | visible | Standard Yoruba – neutral blocking |
| c. | èlùbù | inactive | invisible | Ifè Yoruba – transparent |

The combination of variation in in/activity and in/visibility produces a ternary distinction in the behaviour of Yoruba close vowels. The Ekiti variety of Yoruba displays active/visible harmonising close vowels, Ifè Yoruba displays inactive and invisible transparent close vowels, and Standard Yoruba illustrates a third type with inactive but visible neutral blocking close vowels.¹ Building on Contrastive Hierarchy Theory (Dresher, Piggott & Rice 1994; D. C. Hall 2007; Dresher 2003, 2009; Iosad 2017a), I argue this three-way distinction in in/activity and in/visibility is a product of the hierarchical definition of feature contrastivity and feature classes. Specifically, the visibility or invisibility of a feature [F] to patterns which manipulate a feature [G] is captured in the contrastive hierarchy architecture by varying the order of featural divisions, as specified by the Successive Division Algorithm (SDA) in (141), repeated from (39). According to the SDA, feature contrasts for [F] depend on and are therewith visible to higher ordered feature contrasts.

(141) **Successive Division Algorithm with emergent features and feature-nodes**
(adapted from D. C. Hall 2007, p. 31)

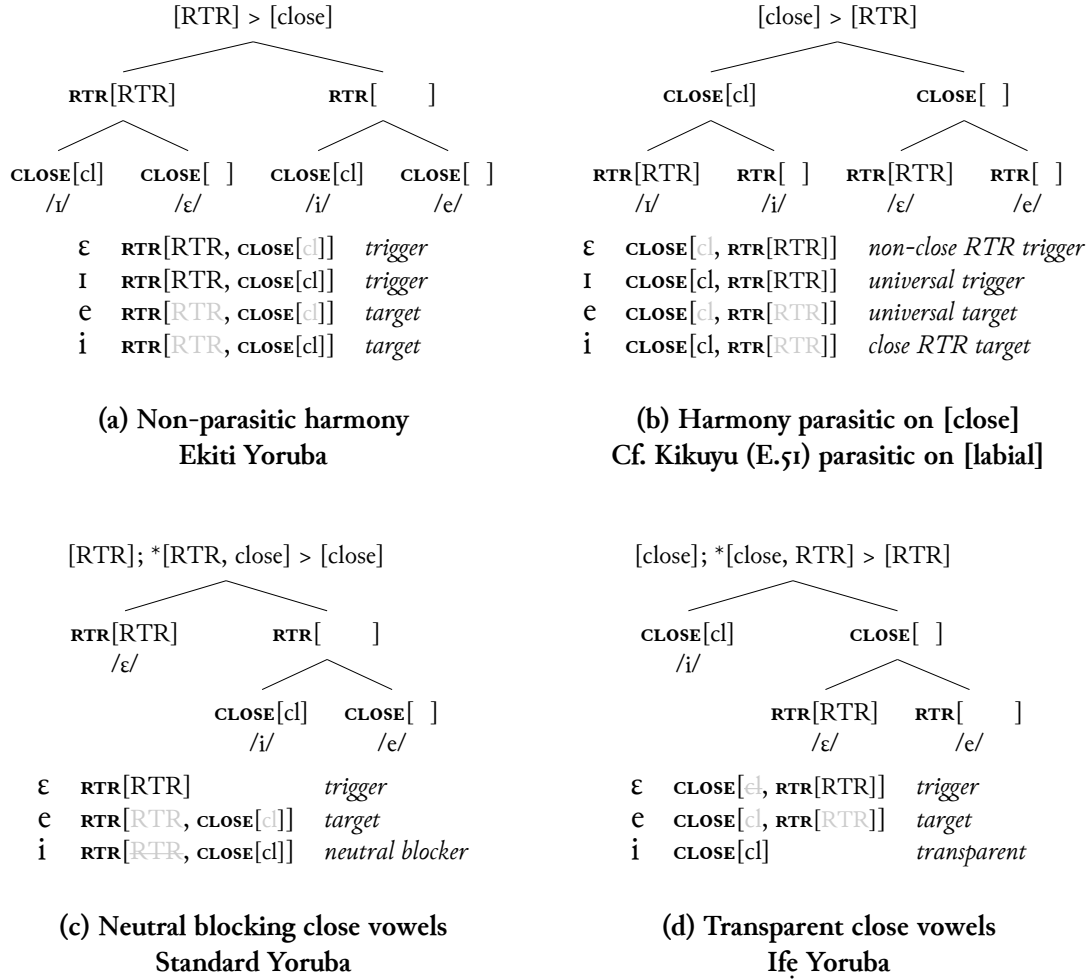
- The input (I) to the algorithm is one or more ordered feature and feature co-occurrence micro-cues.
- If I is found to contain a feature, then it is divided into two (non-empty) sub-inventories: a marked set M, to which is assigned $\mathbf{F}[F]$, and its unmarked complement set \bar{M} , to which is assigned $\mathbf{F}[\]$, obeying $[F, G]/*[F, H]$ co-occurrence restrictions.
- M and \bar{M} are then treated as the input to the algorithm; the process continues until all feature cues are divided

As specified in (141), I have advocated a version of the SDA which takes an ordered set of features and feature co-occurrence micro-cues as its input, returning a contrastively specified inventory of segments as its output. I follow Iosad (2017a) in assuming that the SDA assigns both feature specifications and feature-nodes. Feature-nodes have principally two functions. A node \mathbf{F} defines contrastivity for a feature [F] as well as specifying autosegmental domains; that is, feature-nodes serve as the landing site for processes which spread [F], such as vowel harmony. Features, on the other hand, define marked/unmarked or dominant/recessive classes for [F], producing trigger/target and harmonic/neutral blocking asymmetries in harmony languages.

¹See (19) in section 1.3.2 for a parallel illustration of this ternary distinction in low vowel activity/visibility in Bantu height harmony.

For each feature, as permitted by obligatory/prohibited $[F, G]/*[F, H]$ co-occurrence micro-cues, the SDA produces a division between an unmarked set, which is assigned a bare feature-node $F[]$, and a corresponding marked set, which is assigned a feature-node *and* a privative feature specification $F[F]$. This version of the SDA distinguishes therewith three kinds of feature specification: marked $F[F]$ (*contrastive specification*), unmarked $F[]$ (*contrastive non-specification*), and \emptyset (*non-contrastive underspecification* in the absence of both feature specifications and feature-nodes).

Figure 7.1: Possible SDA outputs and corresponding RTR harmony behaviours assuming $[RTR]/[close]$ with and without prohibited $*[RTR, close]$ co-occurrence



The combination of representational micro-cues and the SDA produces a limited range of variation in phonological representations and feature relations. An illustration of the predicted typology of feature specifications is provided in Fig. 7.1, assuming two variably ordered features, $[RTR]$ and $[close]$, with and without a prohibited $*[RTR, close]$ co-occurrence restriction. Given alternative feature orderings and permitted or prohibited feature co-occurrence, this model predicts four possible outputs producing 3V and 4V segment inventories. These predicted inventories are nicely summarised by the cross-dialectal microvariation in Yoruba observed above in (140). In Fig. 7.1, I provide the predicted feature hierarchies of each set of representational cues along with each

segment's corresponding predicted harmony behaviour-types for RTR (Yoruba-style) harmony systems. Abstract examples of each harmony type are derivationally illustrated below in section 7.3. As demonstrated by this typology, this framework makes very explicit predictions regarding the relationship between phonological representations and phonological behaviour, providing at the same time a unified account of all common harmony and neutral harmony patterns.

As shown in Fig. 7.1ab, if the features are freely allowed to co-occur – where there are no co-occurrence restrictions – then the sound inventory will be symmetric and all segments are predicted to be visible and active triggers and targets of the corresponding harmony feature, as observed in Ekiti Yoruba. However, where the harmony feature has narrower scope than another feature, such as the [close] > [RTR] ordering in Fig. 7.1b, then harmony patterns will be contingent on [close]-agreement. In this case, the harmony feature (literally) depends on higher scope [close] feature specifications. This produces marked/unmarked [close]/non-close asymmetries in tongue root harmony (so-called ‘parasitic’ harmony), where [close] segments will only harmonise for [RTR] with other [close] segments while non-close segments can harmonise with any [RTR]-specified segment. Such asymmetries are not observed among Yoruba dialects, but see a discussion of Kikuyu (E.51) in section 3.3.1 which displays [RTR]-harmony which is similarly parasitic on [labial].

In asymmetric inventories – for example, where *[RTR, close] co-occurrence is prohibited – two different types are predicted. The feature ordering [close] > [RTR] produces [close] vowels which are underspecified for [RTR] (‘outside the scope of the harmony feature’) – resulting in /i/-transparency (Fig. 7.1d). This pattern is observed in Ife Yoruba. The opposite ordering [RTR] > [close] leaves [close] vowels within the scope of the harmony feature – contrastively non-specified for [RTR], as illustrated in Fig. 7.1c. Here [close] vowels have an **RTR** feature-node and are therefore visible but nevertheless illicit (*[RTR, close]) harmony targets, resulting in *[RTR, close] neutral blocking, as found in Standard Yoruba.

7.3 The contrastive hierarchy and harmony grammars

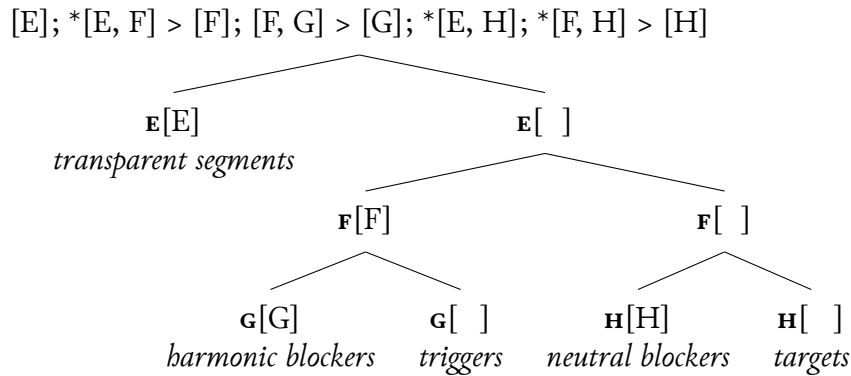
As the examples in Fig. 7.1 illustrate, the contrastive hierarchy method implies a harmony grammar. A harmony feature [F] iteratively spreads from [F]-specified segments to local **F**-nodes as permitted by language-particular feature co-occurrence restrictions. In the way of a harmony operation, I have assumed the general licensing approach outlined in (142), repeated from (74), adapted from Iosad (2017a, pp. 52–54) and Walker (2005), which simply states that vowels (in some position) which are contrastive for the harmony feature should be associated with the harmony feature. This method recapitulates Nevins’ (2010) recipient-oriented Search-and-Copy process or the feature attracting force of Magnetic Grammar (D’Alessandro & van Oostendorp 2018). That is, segments which are contrastively non-specified for [F] are ‘in need’ of an [F]-specification and copy from local [F]-specified feature-donors when available.

(142) LICENSE(V–F, [F]):

‘Vowels which are contrastive for [F] should be associated with [F]’

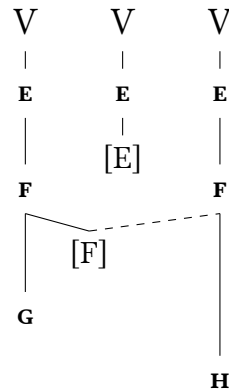
The licensing principle in (142) is limited by the representations output by the SDA. Given the variation in inventory shape and feature specifications, the basic harmony typology predicted by Contrastive Hierarchy Theory can be summarised by the abstract schema in Fig. 7.2, repeated from Fig. 3.10, which represents a language with [F]-harmony. This schema illustrates the specific relationship between feature specifications, relative scope, and co-occurrence restrictions on harmony procedures and may serve as a guide to the analysis of new harmony languages. This framework predicts broadly five types of harmony and neutral harmony behaviours which are outlined below.

Figure 7.2: Harmony typology according to contrastive feature hierarchies



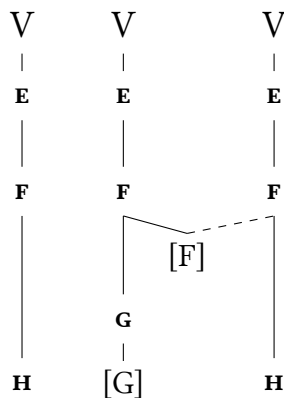
According to the contrastive hierarchy method, harmony processes apply to segments ‘within the scope of the harmony feature’; that is, segments bearing the corresponding harmony **F** feature-node are subject to [F]-spreading. Segments categorised within the scope of the harmony feature are either contrastively specified or non-specified for the harmony feature and bear the corresponding harmony feature-node. These are harmony *triggers* or *donors* (including harmonic blockers), specified **F[F]**, and *recipients* or *targets* (including neutral blockers), contrastively non-specified **F[]**. Segments outside the scope of the harmony feature are non-contrastively underspecified for [F]. These are *transparent segments*, which have no corresponding harmony feature-node and are invisible to the harmony process. Each of these three basic types are demonstrated in Fig. 7.3, which includes an [F]-specified harmony trigger spreading to a non-specified harmony target across an underspecified, transparent segment. Note that the vertical order of feature-nodes in autosegmental representations follows from the order of nodes in the corresponding contrastive feature hierarchy (cf. Fig. 7.2). In these representations, [G] and [H] are not crucially ordered since they exclusively occur on separate branches in the contrastive hierarchy in Fig. 7.2.

As illustrated in Fig. 7.2, neutral or non-alternating segments (blockers and transparent segments) represent inventory asymmetries. Such asymmetries follow from two types of restrictions on the co-occurrence of harmony and orthogonal features: e.g. obligatory [F, G] and prohibited *[F, H] co-occurrence. Obligatory [F, G] co-occurrence requires [G]-specifications to co-occur with [F]-specifications. This relationship is unidirectional; in magnetic grammarian terms, [F] attracts [G] (D’Alessandro & van Oostendorp 2018). This produces an asymmetric inventory, including [F, G] /x/, [F] /y/, and non-specified [] /z/. Prohibited feature co-occurrence restrictions such as *[F, H] symmetrically prohibit [F] and [H] from co-occurring, producing a similar asymmetric inventory: [F] /x/,

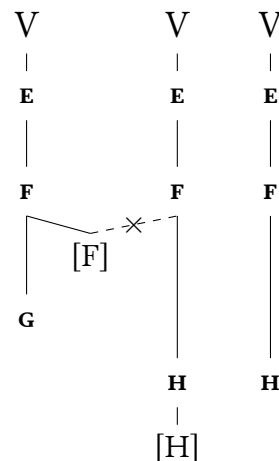
Figure 7.3: Transparent skipping of [F]-underspecified segments

[H] /v/, and non-specified [] /z/. Blocking in harmony patterns occurs when [G] and [H] features occur within the scope of [F] as in Fig. 7.2.

[G]-specified segments in Fig. 7.2 are *harmonic blockers*, necessarily specified for the harmony feature as a result of obligatory [F, G] co-occurrence. Harmonic blocking is illustrated in Fig. 7.4a where a harmonic blocker intervenes between two non-specified segments (members of the unmarked or non-F set), resulting in a mixed surface harmony pattern. [H]-specified vowels in Fig. 7.2 are *neutral blockers*. Neutral blockers bear the harmony feature-node F[] and are therefore visible harmony targets, but the application of harmony would produce an illicit result (*[F, H]). Neutral blockers therefore defectively intervene in the harmony process, as demonstrated in Fig. 7.4b.

Figure 7.4: Harmonic [F, G] and neutral *[F, H] blocking patterns

(a) Harmonic blocking
[F, G]-segments



(b) Neutral blocking [H]-segments
(*[F, H])

This method provides an explicit account of how each harmony behaviour follows from unique feature specifications. A corollary of this approach is that a language's phonological representations can be inferred in a straightforward manner from surface harmony patterns by plugging in the corresponding harmony segments into the schema in Fig. 7.2. This framework is accordingly remarkably easy to implement since the analysis follows from strict and precise principles. There is a single pathway to each harmony behaviour type.

In sum, this framework offers a bottom-up approach to the emergence and acquisition of phonological features as well as their top-down organisation and specification. This provides a clear method of how the language learner derives the representation of her active phonological features, individual segments, feature classes, and whole sound inventory from regular phonological generalisations. Using harmony phenomena as detailed empirical test cases, I have demonstrated the typological adequacy of this framework and the accuracy of its predictions.

7.4 Conclusion

I began this thesis with a question of the division of labour in phonology, contrasting alternative grammatical and representational approaches to the same problem – neutral blocking segments in harmony languages. Any model of phonology requires both a theory of representations and operations. I have emphasised the importance of representational architecture first and grammar second. Conceptually, I believe this principle is advantageous. We need an account of phonological representations anyway, so it is favourable if we can simultaneously capture common segmental phonological patterns using the existing representational framework while eschewing operationally specific grammatical devices. In other words, before we assume some property of language is the product of innate grammatical constraints or rules, we should rule out the possibility that that property emerges from existing representational structures.

This approach raises many tough questions. What is the nature of phonological features, and how are they learned, constrained, and organised? [D. C. Hall \(2018\)](#) suggests a basic methodology: ‘try the most parsimonious representations first because they should be the easiest to falsify.’ The basic representational requirements are informed by contrasts ([D. C. Hall 2018](#)):

Lexical contrast identifies the minimum of information we need. Each phoneme must have enough features (or elements, etc.) to distinguish it from the others with which it contrasts. The opposite end of the continuum – the maximum amount of information – is harder to falsify and harder to identify. We could store phonetic details of every token of every unit (word? morpheme? phone?) the speaker is exposed to...but if we start by assuming it’s all also available to the grammar, what would ever tell us that some of it *isn’t* there?

I have worked to provide what I see as the absolute minimal representational architecture required to account for the emergence, acquisition, specification, and common patterning of phonological features. In this work, I have dedicated particular focus to harmony systems, which I believe provide the most explicit laboratory with which to explore these kinds of questions. Harmony processes’ many moving parts, obvious class behaviour, insights on locality, token frequency, and reliable representation in written corpora offer substantial insights into the nature, categorisation, and representation of phonological features. Following these insights, I have advocated an emergentist, substance-free approach to phonological representations, limited by the contrastive hierarchy and a model of acquisition which posits emergent features and feature co-occurrence limitations on the basis of observed phonological contrasts and alternations.

This approach provides a unified account of harmony and neutral harmony behaviour types as well as precise diagnostics for distinguishing parasitic and non-parasitic harmony,

all of which are seen as emergent effects of the categorisation and co-occurrence of features in contrastive feature hierarchies. This highly predictive framework stands to make substantial contributions to old and new problems alike. As an extended empirical test case, I have given particular focus to Old Norwegian in this thesis.

Old Norwegian is an important and unique specimen, demonstrating a complex sound inventory as well as vowel harmony with multiple kinds of harmony neutrality, substantial cross-dialectal variation, and intricate interactions with other sound processes and ongoing sound changes. The complexity of Old Norwegian vowel patterns and the philological nature of the available evidence makes the study of Old Norwegian vowel patterns particularly challenging. Using novel corpus linguistic methods, I have provided a richly annotated database of Old Norwegian sound patterns. With these data, I have shown how the explicit predictions of the contrastive hierarchy framework allow the phonologist to make principled inferences about historical phonological representations on the basis of phonological patterns evidenced in the textual source material. This puts the work of historical phonology on much firmer methodological footing and has led to important corrections in the generalisation of Old Norwegian vowel classes. This philologically informed, corpus phonological study provides typologically consistent and coherent answers to many classical problems in Old Norse phonology and philology, demonstrating the ability of this framework to provide novel insights on detailed empirical problems which otherwise have resisted explanation.

In sum, the Correlate Contrastivist Hypothesis in combination with the Successive Division Algorithm provides a precise and limited mechanism by which language learners acquire their segment inventories and define contrastive feature specifications relevant to their segmental phonology. I have attempted to show on the basis of substantial empirical evidence from old and new data alike that this method supplies a typologically accurate model and an insightful account of the link between phonological representations and phonological patterning.

Much work is still required to pursue and challenge the assumptions and predictions made in this thesis. Looking forward, in the spirit of recent cross-modular approaches such as Magnetic Grammar (D'Alessandro & van Oostendorp 2018) and Nevins' (2010) *Crossmodular Structural Parallelism*, I believe the core insights of this framework – the hierarchical categorisation of features limited by obligatory/prohibited co-occurrence restrictions – can be made more general, which I hope will prove useful beyond the domain of vowels and vowel harmony. However, if this thesis in any way aids the reader in drawing new insights on problems related to the role of phonological contrastivity in phonological patterns, it will have served its purpose.

Appendix A

Cross-linguistic representational generalisations

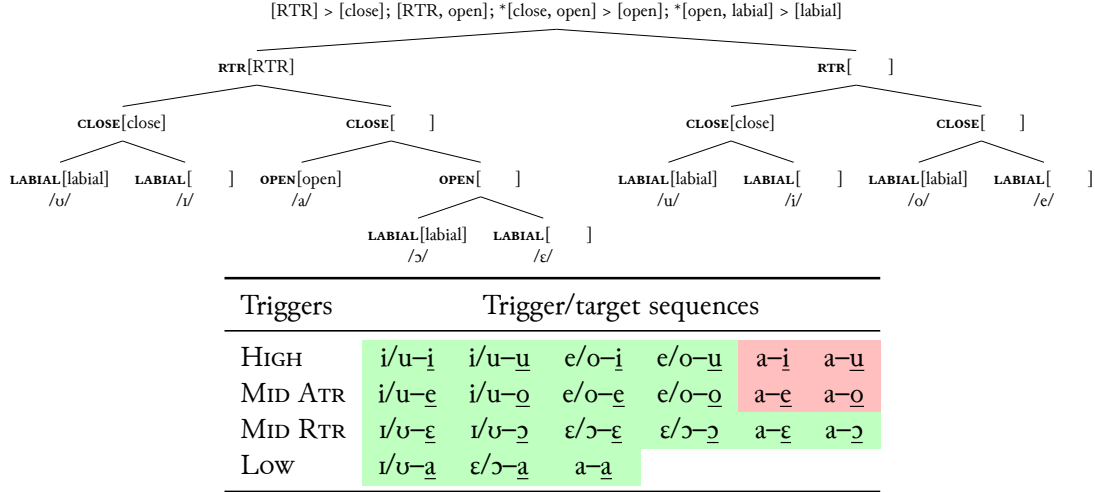
This appendix provides full vocalic representational generalisations for harmony languages cited in this thesis. In its electronic version, cross-references are linked and can be easily navigated by clicking on section and figure numbers. Languages are organised by language family. Included is a summary of each language's harmony systems and important cross-linguistic parallels or counterparts. I have also included representative samples of each language's disyllabic vowel sequences with underlined harmony triggers.

I have made surface harmony generalisations over these sequences, colouring each vowel pair as either harmonic, partially harmonic, transparent, or disharmonic. For the sake of comparing surface harmony patterns across languages, these characterisations are purely descriptive – i.e. not based on any theoretical analysis. A green **x-x** represents a harmonic sequence, an orange **x-y** indicates a sequence in a dual harmony system which is harmonic for one harmony feature but not two, and a grey **x-V** represents a transparent segment; that is, a segment which, in principle, could co-occur with any other vowel type. Finally, a red **x-z** indicates a disharmonic sequence. In each language these vowel patterns follow from the corresponding contrastive feature hierarchy. These cross-linguistic comparisons demonstrate the adequacy of hierarchically organised features and feature co-occurrence restrictions at capturing wide and narrow ranges of vowel harmony variation.

A.1 Atlantic-Congo – Yoruba, Ekiti

Ekiti Yoruba features [RTR]-harmony, which spreads leftwards from root-final syllables (Ola Orié 2001, 2003). The vowel inventory and vowel harmony system of Ekiti Yoruba is very similar to other Yoruba varieties, except that Ekiti Yoruba displays no co-occurrence restriction on [RTR] and [close], producing symmetric, harmonising [close] vowels in target positions (cf. Ifè Yoruba in A.2 and Standard Yoruba in A.3). Since [RTR, close] /ɪ, u/ vowels have historically developed from [RTR]-harmony which spreads from root-final syllables, there are no minimal /i, u, ɪ, u/ distinctions in root-final positions and therefore no [V-ɪ] or [V-u] sequences below. Ekiti Yoruba, like other Yoruba varieties, features non-parasitic harmony. [open] /a/ is a harmonic blocker.

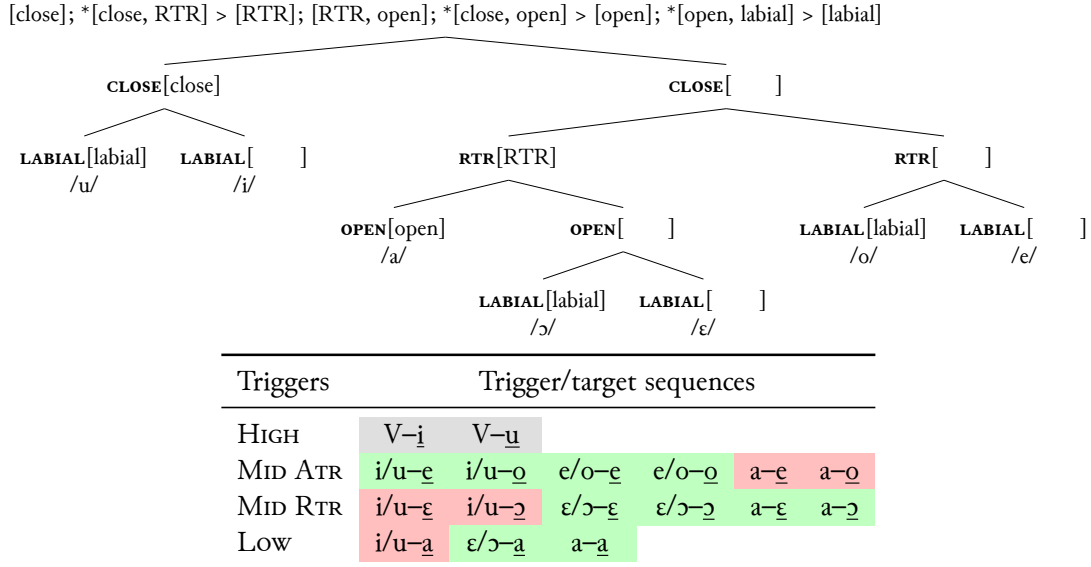
Figure A.1: Ekiti Yoruba contrastive feature hierarchy



A.2 Atlantic-Congo – Yoruba, Ife

Ifẹ Yoruba displays non-parasitic [RTR]-harmony, which spreads leftwards from root-final syllables (Omişore 1989; Ọla Orié 2001, 2003; Przeddziecki 2005; Drescher 2013, 2015). Ifẹ Yoruba is very similar to other varieties of Yoruba (cf. Ekiti Yoruba in A.1 and Standard Yoruba in A.3), except that Ifẹ Yoruba displays two classes of neutral segments with distinct behaviours. [close] /i, u/ vowels are invisible/transparent while [open] /a/ is a harmonic blocker. Non-close/non-open /e, o, ɛ, ɔ/ display harmony alternations.

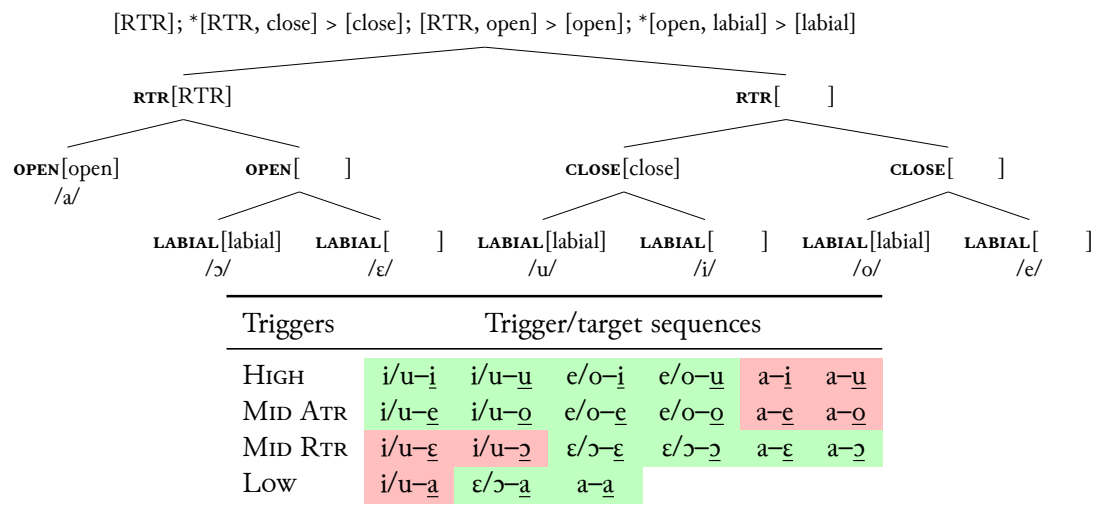
Figure A.2: Ifẹ Yoruba contrastive feature hierarchy



A.3 Atlantic-Congo – Yoruba, Standard

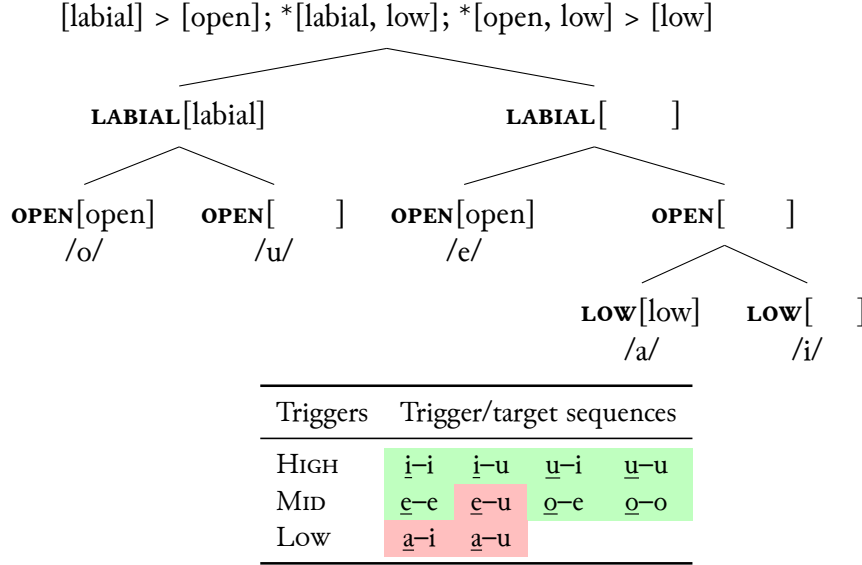
Standard Yoruba is one of the most well-studied and cited harmony languages. For a sample of the central literature on Standard Yoruba, see Awobuluyi (1967); Bamgbose (1967); Archangeli & Pulleyblank (1989); Pulleyblank (1996); Ola Orié (2001, 2003); Nevins (2010); van der Hulst (2012, 2018); Archangeli & Pulleyblank (2015); Drescher (2013, 2015). Standard Yoruba features a 7V-inventory and [RTR]-harmony which spreads leftwards from root-final syllables. It is very similar to other varieties of Yoruba, displaying the exact same inventory and harmony patterns as Ekiti Yoruba (A.1), except that Standard Yoruba displays an additional *[RTR, close] co-occurrence restriction which Ekiti Yoruba lacks. Like Ifè Yoruba (A.2), this makes Standard Yoruba [close] vowels neutral/non-alternating with respect to [RTR]-harmony. In contrast to Ifè Yoruba, however, Standard Yoruba displays an [RTR] > [close] ordering, making [close] vowels visible, neutral blockers of [RTR]-harmony. Like other Yoruba dialects, [open] /a/ is a harmonic blocker in Standard Yoruba.

Figure A.3: Standard Yoruba contrastive feature hierarchy



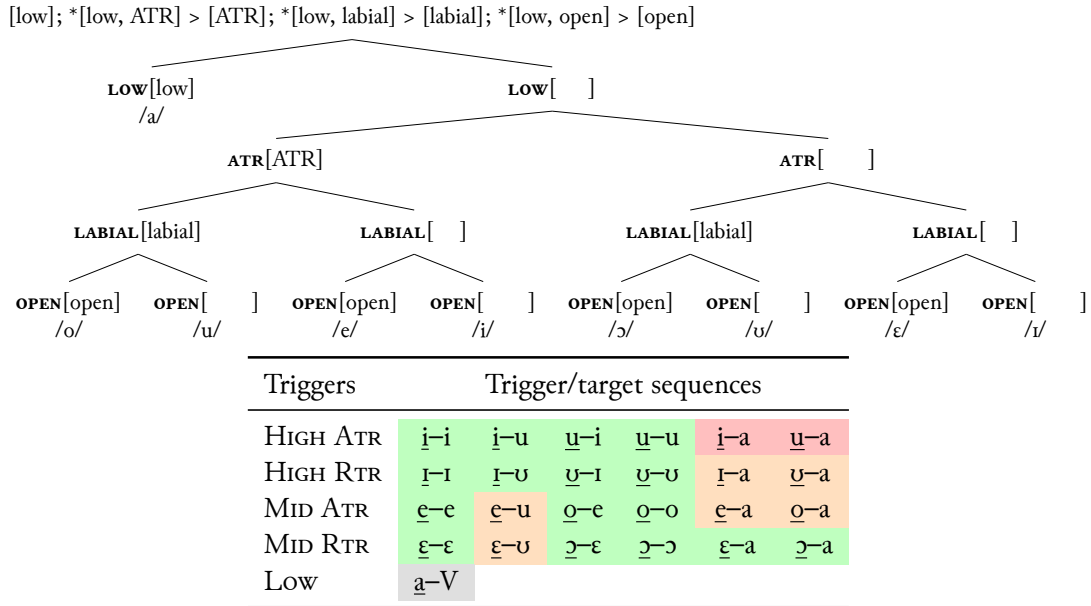
A.4 Bantu – Chewa (N.31)

The contrastive hierarchy in Fig. A.4 is representative for canonical 5V-Bantu languages (see Odden 2015, Hyman 1999, and Clements 1991 for overviews). Representative languages include Chewa (N.31), (Mtenje 1985; Downing & Mtenje 2017; Harris 1994; Sculle 1992); Shona (S.10), (Beckman 1997, Fortune 1955); Yao (P.21), (Ngunga 2000; Archangeli & Pulleyblank 2015); Kisa (JE.32D), (Sample 1976; Hyman 1999, pp. 237–38); Ngoni of Tanzania (N.12), (Ngonyani 2004), among many others. These languages display height harmony via vowel lowering which is very similar to South Kongo (A.11) or Old Norwegian (A.13) except that Chewa-type harmony is parasitic on [labial]. Chewa-type height harmony also has close parallels in other 5V-Bantu languages, such as Mbunda (see A.8), except that [low] /a/ is neutral blocking in Chewa height harmony.

Figure A.4: Chewa contrastive feature hierarchy

A.5 Bantu – Gungu (J.10)

Gungu or Lugungu (J.10) displays overlapping dominant/recessive tongue root harmony and perseveratory or rightwards height harmony via vowel lowering, which results in four-way alternations in non-low vowels (e.g. [i, ɪ, e, ɛ]) (Kutsch Lojenga 1999, Diprose 2007). Like Ndendeule (A.9), low vowels are transparent to both harmony processes. In Gungu, [ATR]-harmony is non-parasitic while [open]-harmony is parasitic on [labial] (cf. Ndendeule where tongue root and height harmony are both parasitic).

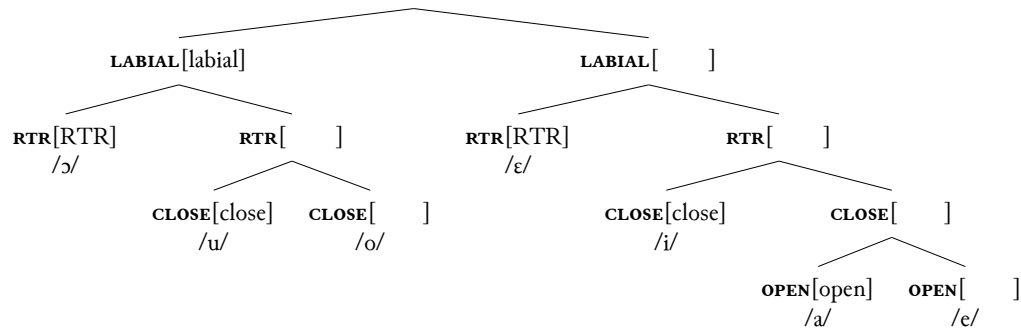
Figure A.5: Gungu contrastive feature hierarchy

A.6 Bantu – Kikuyu (E.51)

Kikuyu (E.51; aka Gikuyu) displays [RTR]-harmony. This harmony system is fairly similar to Nkundo (A.10) but spreads from root-initial to non-initial syllables and is parasitic on [labial] (Armstrong 1940, Peng 2000). [low] /a/ and [close] /i, u/ are neutral blocking

Figure A.6: Kikuyu contrastive feature hierarchy

[labial] > [RTR]; *[RTR, close] > [close]; *[labial, open]; *[close, open]; *[RTR, open] > [open]



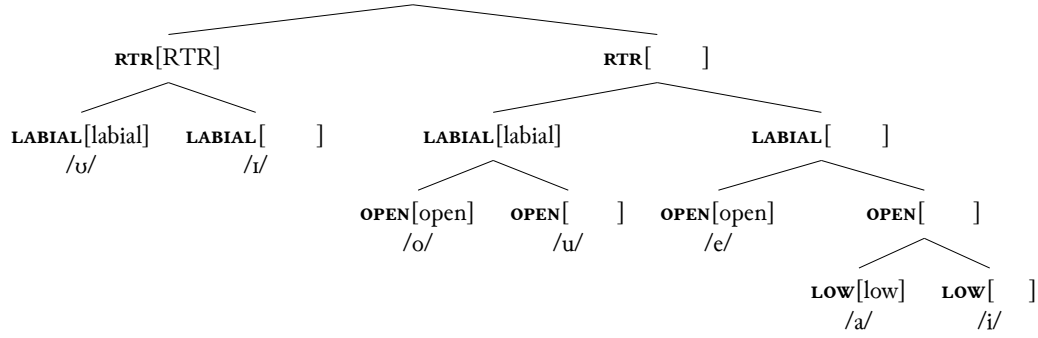
Triggers	Trigger/target sequences									
	NON-LABIAL					LABIAL				
HIGH	i-i	i-u	i-e	i-o	i-a	u-i	u-u	u-e	u-o	u-a
MID ATR	e-i	e-u	e-e	e-o	e-a	o-i	o-u	o-e	o-o	o-a
MID RTR	ɛ-i	ɛ-u	ɛ-e	ɛ-o	ɛ-a	ɔ-i	ɔ-u	ɔ-e	ɔ-o	ɔ-a
LOW	a-i	a-u	a-e	a-o	a-a					

A.7 Bantu – Matuumbi (P.13)

Matuumbi (P.13) features a seven-vowel inventory with two distinct harmony patterns (Odden 1987, 1996), height harmony via vowel lowering among non-RTR vowels (e.g. [i, e]) and [RTR]-harmony among non-open vowels (e.g. [i, ɪ]). These harmony patterns display differing relations to [labial]. [open]-harmony is parasitic on [labial] while [RTR]-harmony is not. [low] /a/ is a neutral blocker of both harmony patterns, similar to canonical Bantu height harmony (cf. Chewa in A.4).

Figure A.7: Matuumbi contrastive feature hierarchy

[RTR] > [labial]; *[RTR, open] > [open]; *[RTR, low]; *[labial, low]; *[open, low] > [low]



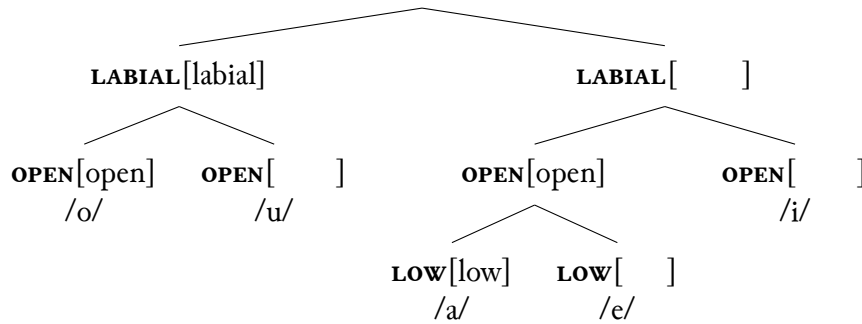
Triggers	Trigger/target sequences					
HIGH ATR	<u>i</u> -i	i- <u>u</u>	<u>u</u> -i	u- <u>u</u>	<u>i</u> -a	<u>u</u> -a
HIGH RTR	<u>ɪ</u> -ɪ	ɪ- <u>ʊ</u>	<u>ʊ</u> -ɪ	ʊ- <u>ʊ</u>	<u>ɪ</u> -a	<u>ʊ</u> -a
MID ATR	<u>e</u> -e	e- <u>u</u>	<u>o</u> -e	o- <u>o</u>	<u>e</u> -a	<u>o</u> -a
Low	<u>a</u> -i	a- <u>u</u>	<u>a</u> -a			

A.8 Bantu – Mbunda (K.15)

The contrastive hierarchy in Fig. A.8 is representative for Mbunda (K.15) and related 5V-Bantu languages, such as Pende (L.11/K.52) (Gowlett 1970; Niyonkuru 1978; Hyman 1999, p. 242). These languages display height harmony via vowel lowering which is parasitic on [labial]. Unlike canonical Bantu harmony systems (A.4), [low] /a/ is harmonic in Mbunda and therefore a harmonic blocker in non-initial (target) positions.

Figure A.8: Mbuunda contrastive feature hierarchy

[labial] > [open]; *[labial, low]; [open, low] > [low]

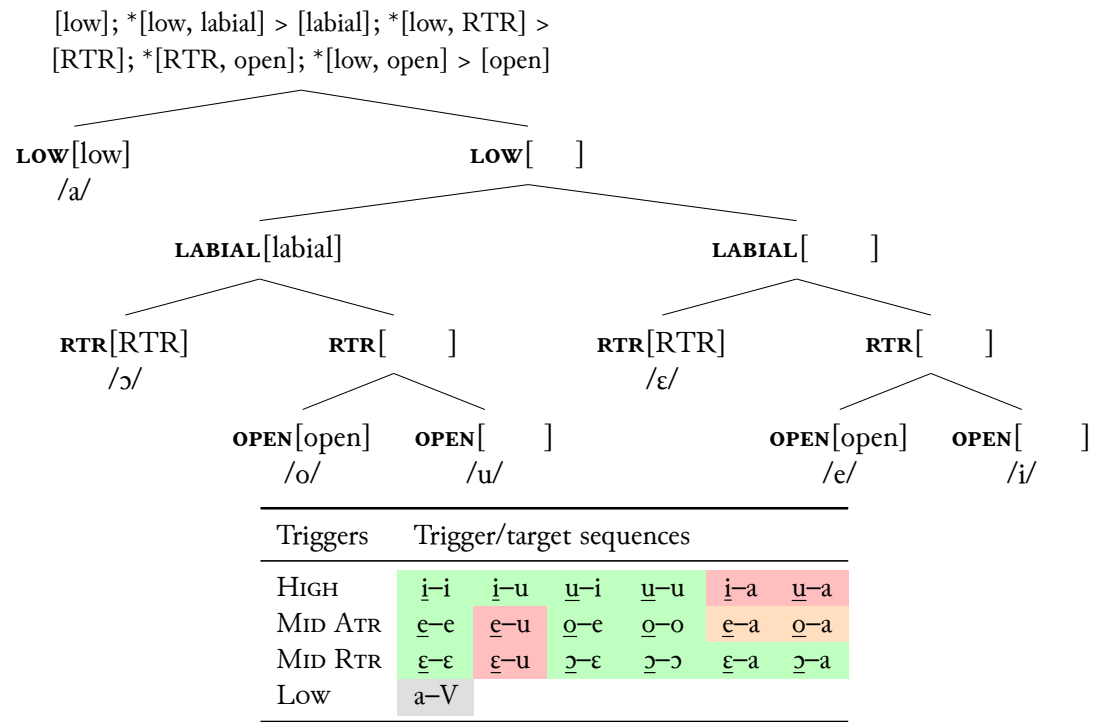


Triggers	Trigger/target sequences			
HIGH	<u>i</u> -i	i- <u>u</u>	<u>u</u> -i	u- <u>u</u>
MID	<u>e</u> -e	e- <u>u</u>	<u>o</u> -e	o- <u>o</u>
Low	<u>a</u> -e	a- <u>u</u>		

A.9 Bantu – Ndendeule (N.101)

Ndendeule (N.101) displays a seven-vowel inventory and two distinct harmony systems, height harmony via vowel lowering and [RTR]-harmony among mid vowels, both of which are parasitic on [labial] and spread rightwards from root-initial syllables. Ndendeule displays a rare system where [low] /a/ is transparent to lowering harmony (Deo Ngonyani, p.c.; cf. Ngonyani 2004); cf. Gungu (J.10) in A.5.

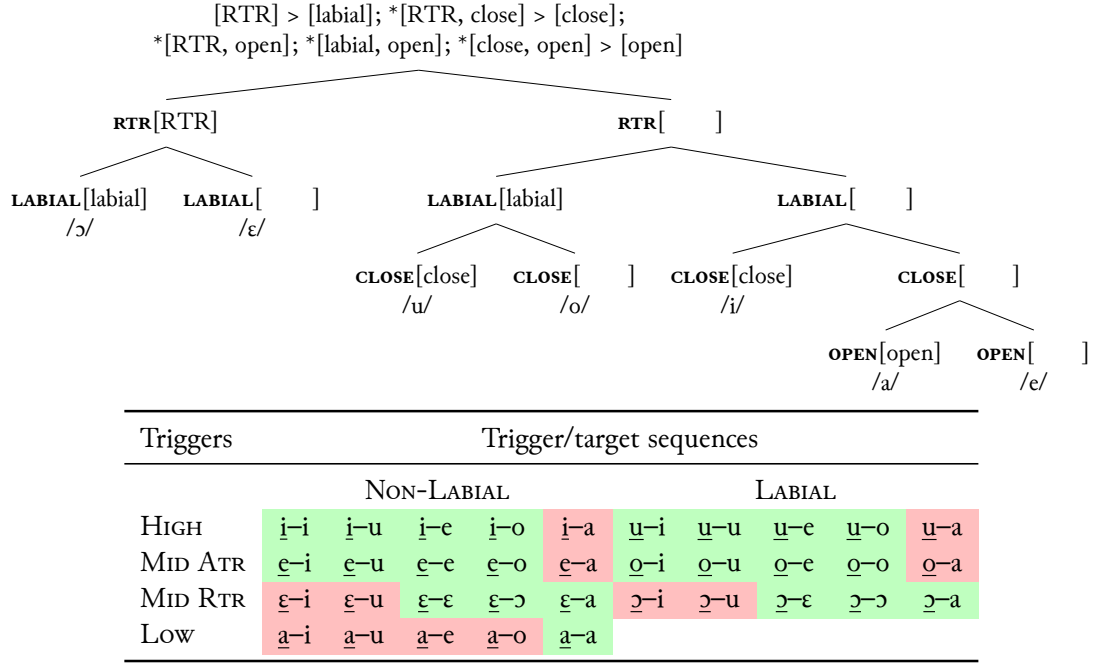
Figure A.9: Ndendeule contrastive feature hierarchy



A.10 Bantu – Nkundo (C.60)

Nkundo (C.61) features dominant/recessive [RTR]-harmony. This harmony system is fairly similar to Kikuyu (A.6) except that it is non-parasitic (Hulstaert 1961, Leitch 1996). [low] /a/ and [close] /i, u/ are neutral blocking.

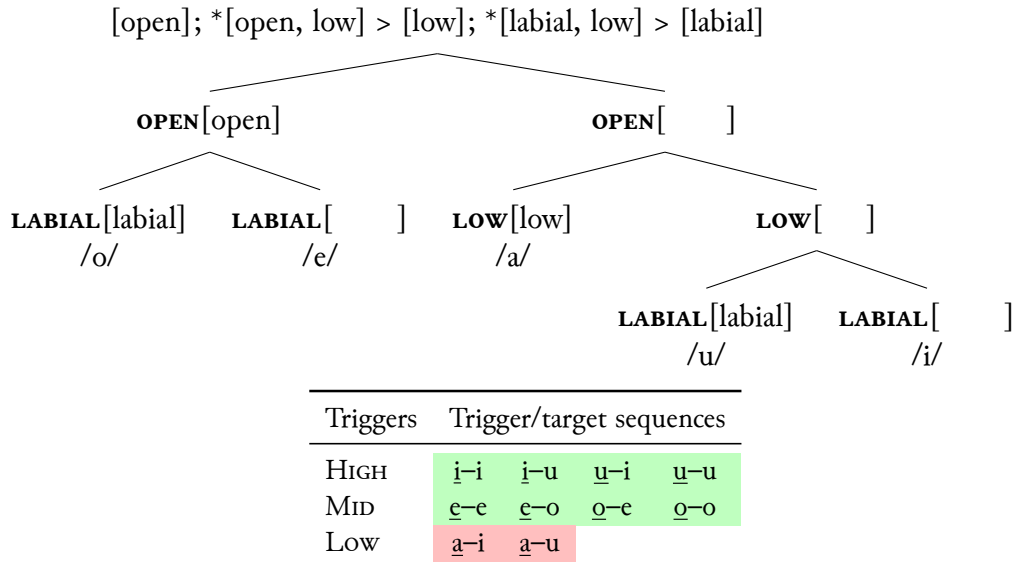
Figure A.10: Nkundo contrastive feature hierarchy



A.11 Bantu – South Kongo (H.16a)

South Kongo (H.16a) displays a five-vowel inventory with height harmony via vowel lowering, as illustrated in Fig. A.11 (Hyman 1999, pp. 241–42). Like canonical Bantu height harmony (see A.4), [low] /a/ is a neutral blocker. Similar to Old Norwegian (A.13), South Kongo vowel harmony is non-parasitic.

Figure A.11: South Kongo contrastive feature hierarchy



A.12 Finno-Ugric – Finnish

Finnish displays an 8V-inventory with asymmetric front/back contrasts. Finnish features non-parasitic front/back harmony with transparent /i, e/ vowels (Ringen 1975; Ringen & Heinämäki 1999; Sulkala & Karjalainen 1992).

Figure A.12: Finnish contrastive feature hierarchy

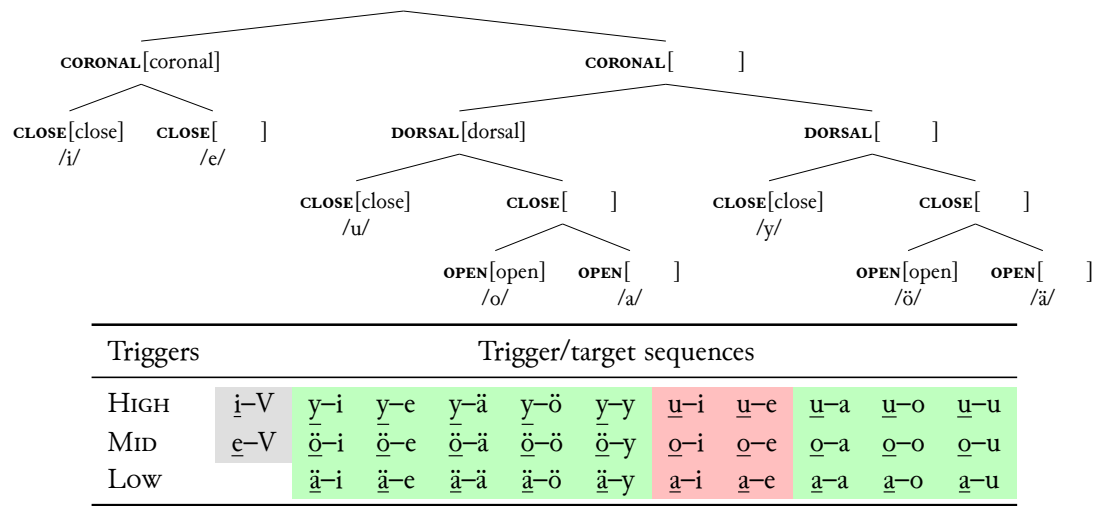
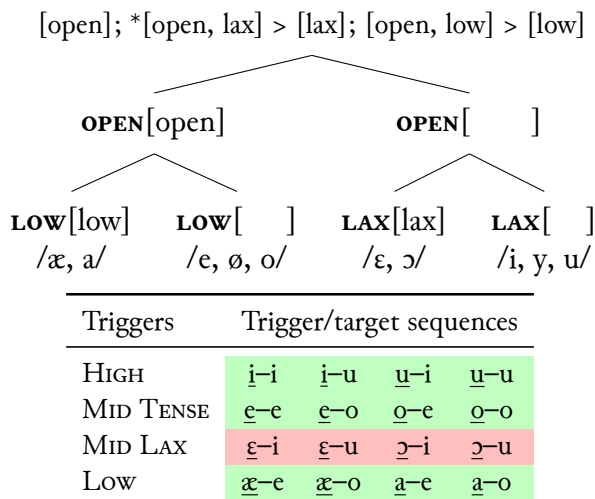


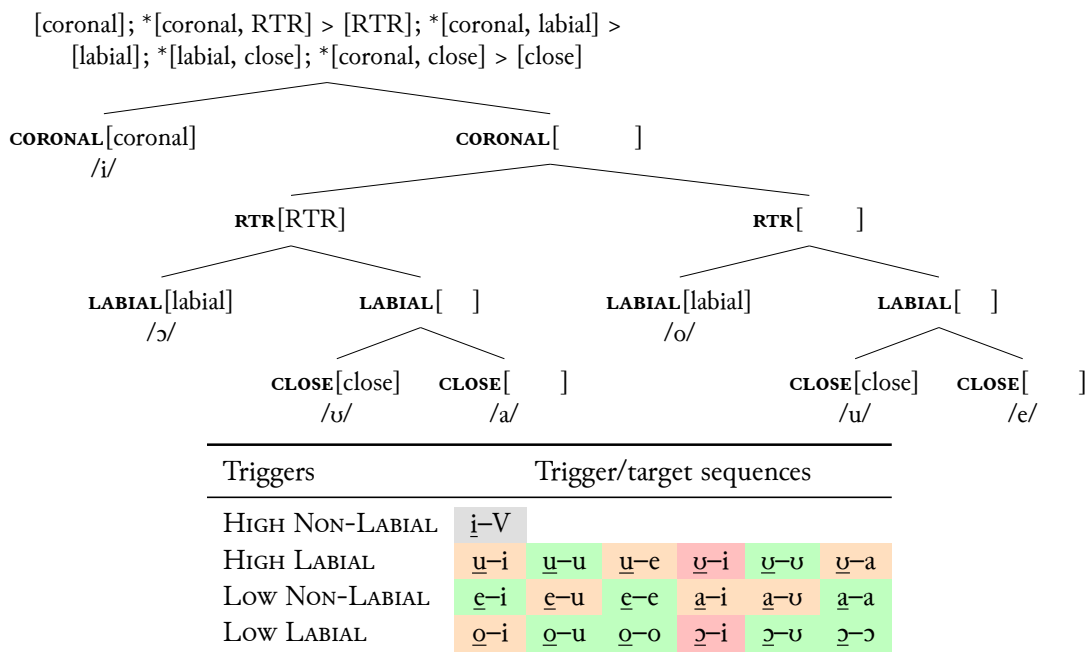
Figure A.13: Old Norwegian partial contrastive feature hierarchy



A.14 Mongolian – Khalkha

Khalkha or Halh (Mongolian) displays a seven-vowel inventory with distinct perseveratory (rightwards) [labial] and [RTR]-harmony. Khalkha features two classes of neutral segments. /i/ is transparent to both harmony patterns while /u, ʊ/ are neutral blockers of [labial]-harmony but fully harmonic with respect to [RTR]-harmony.

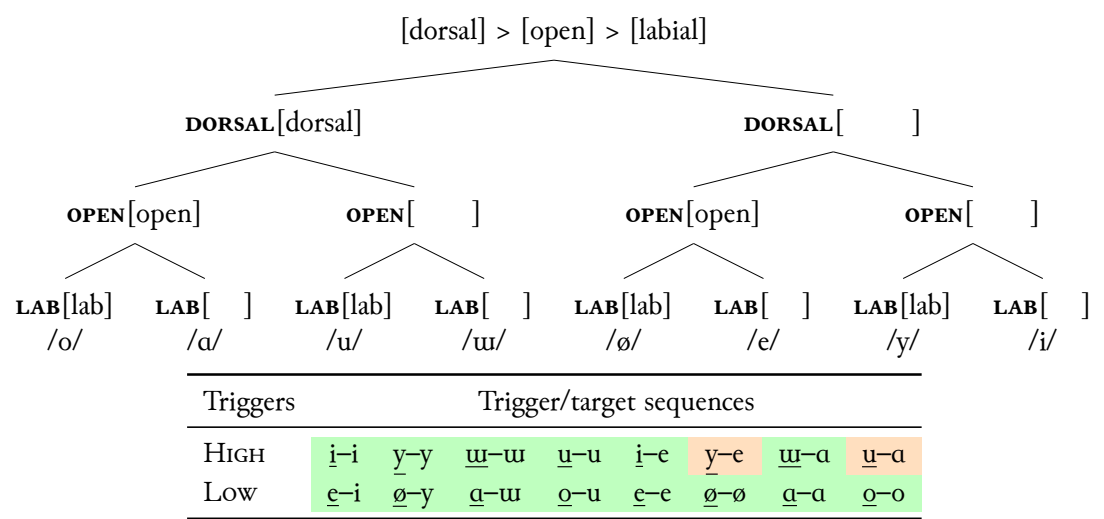
Figure A.14: Khalkha contrastive feature hierarchy



A.15 Turkic – Yakut

Yakut (also known as Sakha), a Siberian-Turkic language, displays a symmetric 8V-inventory with distinct backness and labial harmony, resulting in a four-way contrast – e.g. [e, ø, a, o] (Krueger 1962). Backness harmony is non-parasitic while labial harmony is parasitic on [open], such that non-open vowels are always harmonising targets while [open] vowels will only assimilate to other [open] vowels with respect to [labial]. Yakut vowels and vowel harmony are similar to Turkish (A.16), except that Yakut displays no co-occurrence restriction against [labial] and other height features, and Turkish [labial]-harmony displays no true parasitic asymmetries.

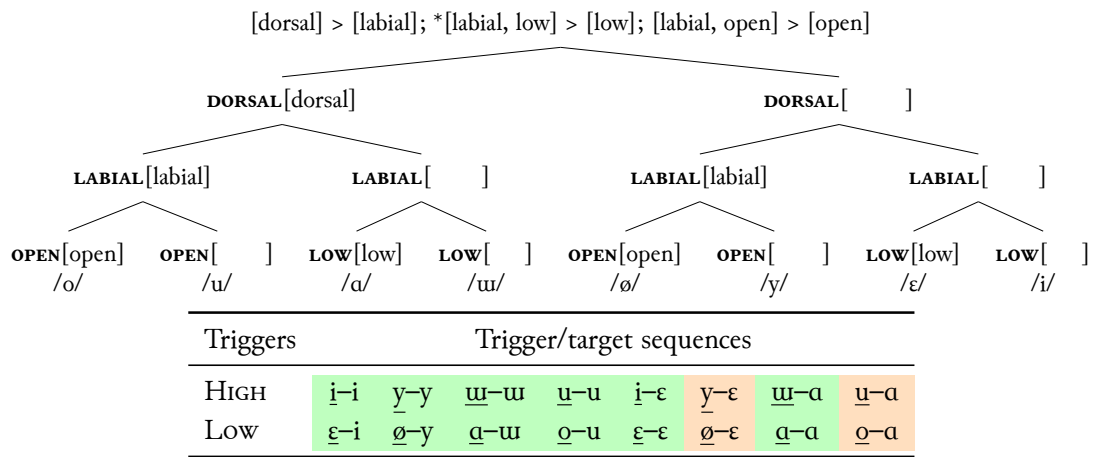
Figure A.15: Yakut contrastive feature hierarchy



A.16 Turkic – Turkish

Turkish displays an 8V-inventory, asymmetrically distributed in vowel height, and features distinct backness and labial harmony (Clements & Sezer 1982, Kabak 2011). Turkish is often analysed as having the same symmetric inventory and labial harmony parasitism as its cousin Yakut (A.15). However, Turkish does not display the diagnostic marked/unmarked asymmetry of true parasitic harmony. Instead, [low] vowels /ɑ, ε/ always fail to undergo [labial]-harmony, demonstrating a categorical *[labial, low] co-occurrence restriction and three relevant vowel heights: symmetric close /i, y, u, ʊ/, [labial, open] /ø, o/, and [low] /ɑ, ε/.

Figure A.16: Turkish contrastive feature hierarchy



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