Glottal Effects in Icelandic Phonology

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In Memoriam
James Joseph Dempsey
1953-2002

I dedicate this work to my beloved nephew
Markús James Dempsey
to his wise and wonderful mother
Guðrún Markúsdottir
to my indispensable sister
Diane Maria Dempsey
and to my very best friend
Ann Marie Carley

TAKK FYRIR
THANK YOU

TABLE OF CONTENTS

Preliminaries

GLOTTAL EFFECTS IN ICELANDIC PHONOLOGY

Chapter One

Chapter Two

The Icelandic Vowel System

Chapter Three

The Icelandic Consonant System

Chapter Four

Glottal Effects

Chapter Five

Aspiration, preaspiration, sonorant devoicing, and deaspiration in Dynamic Phonology

Summary and References

List of Tables and Illustrations

Chapter One

Chapter Two

Chapter Three

Chapter Four

Chapter Five

Introduction

In this dissertation I examine the unique role of glottal articulation in Icelandic phonology. I firmly establish the phenomenon of obstruent lengthening, thereby reducing the number of possible underlying representations of preaspiration from two to one. In so doing, I support the claim that geminate consonants are best represented in terms of units of length, which can be expressed as two segments or two root nodes, rather than units of weight, which are expressed as moras. In addition, I provide a unified account of the apparently disparate glottal phenomena of preaspiration, deaspiration, and devoicing.

I accomplish the unified account of glottal phenomena using a novel phonological model called Dynamic Phonology (DP; Calabrese 1995, 2002, 2003, 2004). In order to provide a background for the new model, in chapter one I present a review of the two most popular phonological theories, plus an overview of DP. In chapter two I show how DP works by applying its precepts to the vowel inventories of Old Icelandic and Modern Icelandic, thereby also showing how the language's vowel inventory evolved. In chapter three I present the consonant inventory of Modern Icelandic, mentioning two interesting aspects of that inventory along the way, including the unusual distribution of the voiceless sonorant phonemes /n̥/, /l̥/, /r̥/ and /j̊/. In chapter four I present all the glottal phenomena of Icelandic, plus several prior analyses of these phenomena. Finally, in chapter five, I unify these phenomena by applying DP to the data.

Chapter One

1.0 Theoretical Overview

The purpose of this chapter is to establish that Generative Phonology (GP) and Optimality Theory (OT) are not adequate individually to realize the description and explanation of glottal effects in Icelandic phonology. To achieve that end, I examine three theoretical approaches to phonology. §1.1 describes traditional GP, and §1.2 addresses the more recent OT. I discuss their merits and shortcomings, and then describe in §1.3 a hybrid approach called Dynamic Phonology (DP) which is under development, and has been published in Calabrese (1995), (2002), and (2003).

1.1 Generative Phonology in Brief

One of the most important goals of phonology is to describe and explain linguistically-significant generalizations, and classical Generative Phonology attempts to capture such generalizations by means of ordered rules. In order to demonstrate how such rules can operate within the framework of GP, I introduce in (1:2) an analysis of *bylur,* the nominative singular form of the Icelandic word for 'snowstorm'. To provide a context for that analysis, I first present in (1:1) the declined forms of *dalur* 'valley' (pronounced [talʏr]), and *bylur* ([pɪlʏr]).

(1:1) The Icelandic strong-declension masculine nouns *dalur*, 'valley' (from Hólmarsson et al. 1989) and *bylur*, 'snowstorm' (from Orešnik 1972a)

Singular Forms	(1:1a)	(1:1b)	(1:1c)	(1:1d)
Nominative Singular	talʏr	pɪlʏr	-ʏr	-r
Accusative Singular	tal	pɪl	--	--
Dative Singular	tal	pɪl	--	--
Genitive Singular	tals	pɪls	-s	-s

Plural Forms	(1:1a)	(1:1b)	(1:1c)	(1:1d)
Nominative Plural	talɪr	pɪljɪr	-ɪr	-ɪr
Accusative Plural	talɪ	pɪljɪ	-ɪ	-ɪ
Dative Plural	tœlʏm	pɪljʏm	-ʏm	-ʏm
Genitive Plural	tala	pɪlja	-a	-a

Based on the items in (1:1a) and (1:1b) it would be plausible to identify (1:1c) as the appropriate set of affixes for this subgroup of strong-declension masculine nouns. Many Icelandic nouns follow the pattern shown in (1:1a), with the Accusative and Dative Singular serving as the stem, and the endings in (1:1c) apparently providing for the other case forms. However, positing that (1:1c) is the correct set of affixes creates two problems - one obvious, and another much less so.

The obvious problem is the presence of the glide [j] in the plural forms of (1:1b). How should [j] be classified? If, on the one hand, this glide were a constituent of the plural endings, it should also occur in the plural forms of (1:1a) - but it does not. If, on the other hand, the glide is part of (1:1b)'s stem, then we would expect it to show up in the singular forms of (1:1b), as well as the plurals. But again, it does not.

The answer put forward in Benediktsson 1969, Orešnik 1972a, Anderson 1974, and Thráinsson 1978b is that the glide *is* part of the stem, and the reason why it does not occur in the singular forms is that a phonological process causes it to delete unless followed by a vowel. This explanation solves the problem for seven out of eight of the forms, but leaves the Nominative Singular, [pɪlʏr], unaccounted for. Notice that the position within [pɪlʏr] where the glide would be expected to occur (after the [l]) is followed by [ʏ], which is a vowel. Therefore the glide should not delete, and the Nominative Singular should be pronounced *[pɪljʏr]. Unfortunately for that analysis, the actual output is [pɪlʏr].

This brings us to the second, less obvious problem associated with (1:1c), namely the composition of the Nominative Singular affix. If the ending were not [ʏr] but rather just [r], the glide deletion rule would eliminate the [j]. This makes (1:1d) the correct set of affixes. Epenthing a [ʏ] to make the Nominative Singular more pronounceable would then round out the process, resulting in the observed form [pɪlʏr].

Crucially, Orešnik's analysis requires that glide deletion be performed upon the underlying form /pɪlj+r/ to yield an intermediate form, /pɪlr/. It is the latter form – the output of the glide deletion process – that then undergoes [ʏ]-epenthesis and surfaces as [pɪlʏr]. The combined operation, an example of ordered rules, is shown in (1:2).

(1:2) Glide deletion and [ʏ]-epenthesis rules, adapted from Orešnik (1972a); both rules derive from work done by Benediktsson (1969) on Old Icelandic.

Underlying Form ..../pɪlj+r/ → /pɪljr/

Glide Deletion......................../pɪljr/ → /pɪlr/

[ʏ]-Epenthesis ..../pɪlr/ → /pɪlʏr/

Output.. [pɪlʏr]

(1:2) demonstrates two important aspects of the ordered rule approach. First, this type of phonological analysis can create intermediate representations, an example of which is the output (/pɪlr/) of the Glide Deletion rule in (1:2). Intermediate representations such as /pɪlr/ are purely abstract in that they never surface; they are "temporary truths" (McCarthy 2002:164), and their only function is to provide an input for the rule that follows.

The second important aspect of the ordered rule approach that should be made clear from (1:2) is that the surface form reveals an opacity that is inherent in the language. This is because the presence on the surface of the epenthetic [ʏ] makes it look as though Glide Deletion should never have taken place (after all, glide deletion requires the *absence* of a following vowel). This type of situation, where the ordered application of rules obscures phonological processes, is called *opacity*, and will be dealt with at length throughout this dissertation. Suffice it to say here that opacity is a very common phenomenon which Generative Phonology explains by means of ordered rules.

The architecture of the Ordered Rule model of GP is rich and complex. It includes lexical, post-lexical, cyclic and non-cyclic components, as well as principles constraining the outputs of those components. In this brief introduction I will skip over GP's architectural details, only presenting them later on when needed for the purposes of the dissertation.

The consequences of GP that I wish to emphasize at this point are *intermediate representations*, whose exact phonological characteristics might not ever surface phonetically, and *opacity*, whereby the phonetic output provides limited (or even no) information about the phonological processes which resulted in that output.

1.1.1 Problems with Generative Phonology

Two major problems with the ordered rule approach emerged almost as soon as the earliest form of GP was formalized in Chomsky and Halley (1968): a failure to account for conspiracies within and across languages, and a failure to account for markedness effects across languages.

1.1.2 Conspiracies

A conspiracy is seen to occur whenever at least two supposedly-unrelated rules in one or more languages produce the same result. So, for instance, Kisseberth (1970) proposed several different rules for Yawelmani that cause syllables to have the following shape: CV({V,C}). That is, in Yawelmani well-formed syllables always have an onset, plus a rhyme that consists of a short vowel, or a long vowel, or a short vowel followed by a single consonant. GP requires a diverse set of rules in different parts of the grammar that generate a variety of changes to Yawelmani prosody, all of which "conspire" to assure that syllables adhere to the CV({V,C}) template. For example, some rules shorten vowels in syllables closed by a consonant, while others insert vowels in three-consonant sequences. These rules are formally unrelated, but functionally united: their point is to cause syllables to be well-formed. Kisseberth recognized that, by its inability to relate these phenomena formally, the ordered rule (GP) model fails to capture linguistically significant generalizations.

Another apparent example of conspiracy occurs cross-linguistically, where some languages do not allow a high vowel to surface next to another vowel. One way to enforce this prohibition is by deleting one of the vowels, as seen in (1:3), a sample of a casual-speech (allegro) form of Mexican-American Spanish (from Hutchinson 1974, cited in Calabrese 2004). The underscore _ in the surface form of (1:3) indicates where the vowel deleted.

(1:3) Resolution of prohibited sequence [-conson] [-conson, +high] by deletion

Gloss	Orthographic	Underlying	Surface
this daughter	'esta hija'	/esta+ixa/	[est_ixa]
the church	'la iglesia'	/la+iɣlesja/	[l_iɣlesja]

In other languages, such as Icelandic, the high vowel becomes a glide. An example of this approach is seen in the declension of *stöð*, the Icelandic word for 'station' (pronounced [stœð]). The data for this analysis comes from Anderson 1969a:70 and Hólmarsson et al. 1989.

(1:4) Resolution of [-conson, +high] [-conson] by glide formation

Nominative Singular	[stœð]	Nominative Plural	[stœðʋar]
Accusative Singular	[stœð]	Accusative Plural	[stœðʋar]
Dative Singular	[stœð]	Dative Plural	[stœðʋʏm]
Genitive Singular	[stœðʋar]	Genitive Plural	[stœðʋa]

(1:4) is another example of opacity because the underlying stem vowel /a/ changes to [œ] in response to the influence of an underlying /u/ that later deletes. Therefore a certain amount of unravelling will be necessary here to demonstrate the effect of glide formation from a high vowel.

My analysis proceeds from Anderson's 1969 assumption that [stœð] 'station' derives from /staðu/ (*stað* = 'location'), and that the presence of /u/ triggers the raising, fronting, and rounding of /a/ to [œ]. This assimilative process, traditionally called u-umlaut, is evident in such Icelandic alternations as *amma* ~ *ömmu* ('grandmother'), *saga* ~ *sögu* ('story'), and *gata* ~ *götu* ('street'). It is also evident in the stem vowel of the Dative Plural form of *dalur* in (1:1a), above.

Glide formation (/u/ → [ʊ]) comes next. It applies, as mentioned above, wherever the high vowel /u/ adjoins another vowel – in this case the initial /a/ or /ʏ/ of the Genitive Singular, Nominative Plural, Accusative Plural, Dative Plural and Genitive Plural endings. A final rule deletes the remaining instances of /u/, thereby creating the opacity.

By focusing solely on the process (i.e. deletion or glide formation), which is all a theory of ordered rules can do, the linguistically significant generalization (in this case *[α high][–α high]) can never be captured.

1.1.2.1 Do conspiracies exist?

The status within current phonological theory of surface generalizations such as *[α high][–α high] points up the disparity between process-oriented approaches like GP, and output-oriented approaches like OT. There is a parallel contention about the very ontology of such generalizations: goal-driven or epiphenomenal. As Kager (1999:56) puts it, "rule-based theory fails to make this prediction of the functional unity of processes because it has no formal means of expressing the 'output goal' of a phonological rule".

The idea of such an 'output goal' is not universally embraced, however. Reiss (2000:298) reminds us that Kiparsky (1973) dismissed the very idea of conspiracy as the result of an epiphenomenon. Here is Reiss's interpretation of Kiparsky's argument:

1. A conspiracy is a set of rules that are "functionally related", that is they lead to the same kinds of output configurations, such as 'all syllables are open'.
2. If a language has such a set of rules, then the rules of the language will tend to be surface true (transparent).
3. Non-transparent (opaque) rules are not surface true.
4. Rules that are not surface true are hard for a learner to learn.
5. Things that are hard to learn are more likely not to be learned than things which are easy to learn.
6. Failure to learn aspects of the ambient language constitutes a diachronic change.
7. Therefore, (E-)languages are more likely to lose opacity than gain opacity.
8. Therefore, grammars are likely to look like they have conspiracies.

"In other words," concludes Reiss, "the existence of conspiracies is an epiphenomenon due to the fact that languages tend to have transparent rules. This in turn is an epiphenomenon derived from the undeniable fact that individual languages must be learned."

In this view, then, conspiracies are nothing more than surface representations of tendencies for language to change based on extragrammatical factors. Reiss (2000) excludes, on teleological grounds, critiques that rule-oriented theory fails to capture conspiracies. He rejects McCarthy's (1999) statements that rule-based theories are inadequate because they "do not make teleological connections," and that "alternations are teleological (they support some endpoint or target)." Supporting an endpoint or target is the basis of teleology, and so, following Reiss, conspiracies are inherently teleological and have "no place in scientific explanation." According to this view, the formal properties of any linguistic theory should suffice to capture conspiracies.

Despite arguments invoking epiphenomena and teleology, many phonologists (myself included) consider that conspiracies represent linguistically-significant generalizations, and that any theory that cannot capture conspiracies, like GP, should be replaced by one that can.

1.1.3 Markedness

The second problem widely attributed to traditional GP is its failure to account for markedness effects across languages. The meaning of markedness, as well as its use in phonological theory, have changed over time, so a (necessarily brief and limited) review of the concept's evolution is in order here.

Markedness was an idea developed by Nikolai Trubetskoy and Roman Jakobson, prominent theorists of the Prague Linguistic Circle (later known as the Prague School), which flourished in central Europe during the 1920s and 1930s. They proposed that, if two phonemes differ from each other by just one distinctive feature, then one value of that feature (and consequently its associated phoneme) will be marked, and the other unmarked. The most neutral or least unusual phoneme would be unmarked, while the other would be considered marked. Hockett (1955) brings into the picture the idea of phonological simplicity; he equates simplicity (the unmarked state) with breadth of distribution, specifying that "if one of two or more matching sets of units has a wider distribution, the former is phonologically simplest."

So, for example, Hockett points out that in the North American language Winnebago, aspirated stops occur initially, medially, and finally, while unaspirated stops occur only in final position. Therefore, aspirated stops possess the status of phonological simplicity (greater breadth of distribution), and so they are unmarked.

Archangeli & Langendoen (1997) associate the unmarked with the universal, as well as "the robustness of a given property within a language." Kager (1999) calls unmarked values "preferred and basic," while the marked serves "only to create contrast." Current ideas of markedness tend to stress that unmarked utterances are more easily pronounced or understood, whereas marked utterances are relatively complex in terms of articulatory or perceptual properties.

The concept of markedness is embraced wholeheartedly by proponents of OT, whose major mechanism is a set of constraints that are ranked and violable (details below, §1.2). Archangeli & Langendoen (1997) point out that "markedness is represented in OT by constraint violation while constraint satisfaction corresponds to unmarked properties," and therefore "markedness is encoded directly in the model. This is an important result, for earlier models [i.e. GP] have required separate theories of markedness." That assertion stands as one of the fundamental motivations for OT.

Kager (1999) goes on to associate markedness with *grounding*: "most phonologists agree that phonological markedness is ultimately grounded in factors outside of the grammatical system proper. In particular, the systems of articulation and perception naturally impose limitations on which sounds (or sound sequences) should be favoured." According to this view, markedness is both theory-internal (dependent upon phonological processes) and theory-external (resulting from phonetic realities).

This situation raises the question of whether it is desirable for any single property, such as markedness, to exist simultaneously as a theoretical construct and as a reality-based phenomenon. Perhaps not. McCarthy (1999) goes out of his way to distinguish "Praguian markedness," which he characterizes using the implicational relationship A iff B (where A is marked and B is unmarked), from "OT markedness," which strictly involves the violation of markedness constraints. Praguian markedness, under this distinction, would correspond to phonetic or theory-external markedness, whereas OT markedness would be phonological or theory-internal.

Given the varied and even conflicting definitions of markedness presented above, any claim that a model is flawed because it does not provide an explanatory context for markedness will run into trouble. After all, two kinds of markedness are possible: theory-external markedness, and markedness that is defined within the context of a theory such as OT. Any approach that reliably links both kinds of markedness would be highly desirable, but that particular goal has proven elusive, even within the OT program; this issue will be discussed further in §1.2, below. Failing phonetic-phonological linkage, a model can restrict itself to incorporating markedness theory-internally. In such an event, however, tailoring the definition of markedness to fit any particular model will dilute the effects of claims that the model encodes markedness.

To conclude this section: generative phonology is a theory of ordered rules and, by necessity, posits purely abstract intermediate representations. Opponents of generative phonology (for the most part supporters of OT) standardly criticize GP for its inability to encode conspiracies and markedness.

Some proponents of generative phonology in turn reject the entire concept of conspiracy as epiphenomenological and teleological, and therefore outside the realm of phonology – and, indeed, linguistics. Markedness is also dismissable either as an extra-phonological (phonetic) phenomenon that results from limitations on the human ability to produce and understand meaningful sounds, or as a theory-internal construct that has no relevance outside the model and therefore yields no explanatory insights.

1.2 Optimality Theory in Brief

Over the past decade, OT (Prince & Smolensky 1993, McCarthy & Prince 1993) has come to dominate the literature in phonological theory. Instead of GP's ordered rules, OT uses a system of interacting well-formedness constraints to map an infinite set of potential outputs directly to a single actual output, without recourse to those abstract intermediate representations that, in GP, amount to "temporary truths."

Under the OT model, any input – a lexical item, for example – is subjected to a mechanism called GEN, which generates all possible output versions of the input. These possible output versions are called candidates. Note that the concept "all possible" is taken quite literally in OT, so the set of candidates created from the input by GEN is always infinite.

The next step that occurs in the OT analysis is EVAL, or evaluation. (OT operations are considered to occur simultaneously, but for simplicity of presentation I will assume a step-by-step series of processes.) EVAL compares the infinite set of candidates against a finite set of violable constraints that control the circumstances under which a candidate can surface. This set of constraints, called CON, is considered part of the universal language faculty. EVAL determines whether or not a given candidate has violated a given constraint, and it also determines which candidate has accumulated the least severe violations; the candidate with the least severe violations surfaces as the phonetic output, while all the others fail.

The constraints that comprise CON are ranked with respect to one another. Every language has a unique constraint ranking, which is what distinguishes each language from all others. The ranking affects whether a given candidate will surface or fail, since violation of a higher-ranked constraint is more dire than violation of a lower-ranked constraint. An example of how constraint violations and constraint rankings interact to determine which candidate will surface - and which will fail - is shown in (1:5a) and (1:5b); these displays are called tableaux.

(1:5a) Icelandic pronunciation of *dal*, 'valley'

/dal/	*VOI-OBS	IDENT-IO(F)
[dal]	*!	
☞ [tal]		*

In (1:5a), the input is /dal/. The relevant ranked constraints are *VOI-OBS (no voiced obstruents are allowed) and IDENT-IO(F) (all input features must be identical to their corresponding output features). *VOI-OBS's position to the left of IDENT-IO(F) in the tableau indicates that *VOI-OBS ranks higher than IDENT-IO(F). As mentioned above, the set of output candidates is infinite, but for convenience I provide just two output candidates, [dal] and [tal]. The asterisk (*) represents a violation of the constraint that is listed above it. The exclamation point (!) indicates that the possible output to its left has failed, and will not surface.

In (1:5a), each candidate violates one constraint. Since in this case *VOI-OBS ranks higher than IDENT-IO(F), and [dal] violates the higher-ranking constraint (because [d] is a voiced obstruent), [dal] fails (!), leaving [tal] to surface. The surface form is indicated by the pointing finger '☞' symbol.

The opposite situation can and does occur in other languages, such as Faroese, as shown in (1:5b).

(1:5b) Faroese pronunciation of *dal*, 'valley'

/dal/	IDENT-IO(F)	*VOI-OBS
☞ [dal]		*
[tal]	*!	

Again, each candidate violates one constraint. In fact, each candidate in (1:5b) violates the same constraint that it violated in (1:5a). The only difference is that the ranking of the constraints has changed. In (1:5b), IDENT-IO(F) ranks higher than *VOI-OBS. Therefore [dal]'s violation of *VOI-OBS (which has not changed) no longer causes [dal]'s candidacy to fail. Instead, [tal]'s violation of IDENT-IO(F) causes [tal] to fail in (1:5b), because IDENT-IO(F) is the higher-ranking constraint. This leaves [dal] to surface.

In this way, simply by reranking constraints, OT can show how languages differ from one another: in Icelandic *VOI-OBS outranks IDENT-IO(F), so /dal/ is pronounced [tal], while in Faroese IDENT-IO(F) outranks *VOI-OBS, so /dal/ is pronounced [dal].

1.2.1 Types of Constraints: faithfulness, and a final word on markedness

The OT program requires at least two distinct categories of constraints: faithfulness constraints and markedness constraints. Faithfulness constraints control the kinds of differences that may obtain between the input and the output. An example of a faithfulness constraint, IDENT-IO(F), was used in (1:5); it broadly requires that the input value (plus or minus) and the output value of any feature (F) must be identical. In (1:5a) and (1:5b), [tal] violated IDENT-IO(F) because the value of one feature ([voice]) of one segment ([d]) of the input /dal/ was not identical to the value of the same feature of the same segment of the output candidate /tal/. Faithfulness constraints encode differences between the input and the output, which means that this class of constraints must always make reference to both the input and the output. This is why it is necessary to claim that each member of the infinite set of output candidates created by GEN carries along with it enough information about its original, pre-GEN input form to allow for EVAL to determine whether faithfulness has been violated in any given situation.

The other major class of constraints – markedness constraints – applies only to the output, without reference to the input. In some situations OT markedness constraints appear to encode and account for some of the articulatory or cognitive restrictions that obtain within the human speech production and perception system. Thus, a case can be made that *VOI-OBS is *grounded* (Kager 1999:5, 7 n4) in the demonstrable (Halle and Stevens 1971) physiological reality that voiced obstruents are more difficult to apprehend than unvoiced obstruents.

If all OT markedness constraints enjoyed the same kind of relationship that the phonological statement *VOICED-OBS has with the realities of phonetics, then the concept of markedness within OT would greatly bolster the explanatory adequacy – and thereby the desirability – of the entire theory. I touched upon this idea in the preceding section. Unfortunately, many markedness constraints are not grounded by any possible corresponding phonetic reality. Some examples:

- *VORAL, which states that oral vowels are marked (McCarthy 2002:186 n11)
- *COR, which states that coronal consonants are marked (Yip 2001)
- *MORA(seg), a set of constraints which label as marked any mora associated with a particular type of segment (Morén & Miglio 2000. Unpublished MS)
- *STRUC, a set of constraints that "militate against all structure whatsoever" (McCarthy 2002:47 n33, from Prince & Smolensky 1993, PC with C. Zoll)

None of these constraints could be claimed to encode any articulatory or perceptual realities about human speech, yet they are necessary for the success of their respective analyses.

One final distinction between theory-external markedness and OT markedness will complete this subsection. Expressions of theory-external markedness do not intereact with each other. Thus, the statement [-sonorant, +voice] iff [-sonorant, -voice] (i.e. voiced obstruents are marked) cannot interact in any way with the statement [+sonorant, -voice] iff [+sonorant, +voice] (i.e. voiceless sonorants are marked); the two (theory-external) markedness statements are apples and oranges, so to speak.

By contrast, OT markedness constraints *can* interact with each other. Paraphrasing an example from McCarthy (2002:26-27), it is not unreasonable to posit an OT markedness constraint in Dutch that favors the epenthesis of a glottal stop when an onsetless syllable is preceded by [aː]. This would be a simple elaboration of ONSET (a constraint favoring syllables with onsets), and is seen in such examples as *a*[ʔ]*órta* 'aorta' or *pa*[ʔ]*élla* 'paella'. I'll call the constraint ONSET+ʔ. Glottal-stop epenthesis does not occur, however, when the onsetless syllable is unstressed: *fára.o* 'Pharaoh', *chá.os* 'chaos'. To explain these facts in Dutch, Optimality Theory requires another markedness constraint, one that will militate against epenthing the weakest possible consonant – the glottal stop – in an onset position for a weak (unstressed) syllable. I'll call that constraint *WEAKONSWEAKσ. Given *chá.os* and *a*[ʔ]*órta,* it is clear that *WEAKONSWEAKσ outranks ONSET+ʔ, and that ONSET+ʔ can only come into play if *WEAKONSWEAKσ is not violated. This type of interaction among expressions of markedness is exclusive to OT markedness, and provides further evidence that any predictable relationship between OT markedness and OT-external markedness remains difficult if not impossible to establish.

In fact, the only thing that can consistently be claimed about OT markedness constraints is that, *strictly within the theory,* outputs that violate markedness constraints are considered marked, and outputs that do not violate markedness constraint are considered unmarked. In order to avoid confusion, therefore, it is important to keep in mind that there exists no identity relationship between OT-internal "markedness" and any other type of markedness.

There are at least three fundamental differences between faithfulness constraints and markedness constraints. First, as mentioned above, faithfulness constraints are ineffective unless they refer to both the input and the output, whereas markedness constraints refer only to the output. Another difference is that faithfulness constraints serve to keep OT from collapsing all inputs into some kind of maximally unmarked output inventory, which obviously does not occur in human language, while markedness constraints provide a motivation for the difference between input and output. Finally, markedness constraints tend to license differences between input and output, whereas faithfulness constraints tend to inhibit such differences.

1.2.2 Opacity as a challenge to OT

In this section, I refer to the set of data presented in §1.1 above. I apply an OT analysis to the data, and show how the analysis fails because of the opaque nature of the data.

Recall that the nominative singular form of the Icelandic word for 'snowstorm' is spelled *bylur*, and pronounced [pɪlʏr]. It is uncontroversial to state that [pɪlʏr] derives from underlying /pɪlj/ + /r/, and that two processes - one involving glide deletion and the other involving [ʏ]-epenthesis - contribute to the output. According to Karvonen & Sherman (1997a), any OT analysis of both of those processes will require the following six constraints:

SONCON	Complex onsets rise in sonority, and complex codas fall in sonority.
REALIZE-M	For every morpheme in the input, the output must contain at least one segment of that morpheme.
$\text{CONTIG}_{\text{MAX}}$	Segments that are contiguous in the input must be contiguous in the output; the portion of the input standing in correspondence forms a contiguous string.
DEP-IO	Every segment in the output has a correspondent in the input.
ANCHOR-R	Any element at the right edge of the input has a correspondent at the right edge of the output.
MAX-IO	Every segment in the input has a correspondent in the output.

Given the input /pɪljr/, the application of the constraints SONCON, REALIZE-M, CONTIG$_{MAX}$, DEP-IO, ANCHOR-R, and MAX-IO will yield the OT tableau shown in (1:6).

(1:6) OT analysis of /pɪlj/ + /r/, based on Karvonen & Sherman (1997a). The symbol "☞" indicates the most harmonic candidate, while the symbol "💣" indicates the candidate that actually surfaces, despite its status as non-optimal.

/pɪlj + r/	SONCON	REALIZE-M	CONTIG$_{MAX}$	DEP-IO	ANCHOR-R	MAX-IO
a) pɪl		*!			*	**
b) pɪlj	*!	*			*	*
c) pɪlr	*!		*			*
d) pɪljr	*!					
e) 💣 pɪlʏr			*!	*		*
f) ☞ pɪljʏr				*		
g) pɪljʏ		*!		*	*	*

In (1:6), the deletion of the case-assignment morpheme /r/ violates REALIZE-M, causing candidates (1:6a) and (1:6g) to fail. Candidates (1:6b), (1:6c), and (1:6d) fail because their coda clusters do not fall in sonority, thereby violating SONCON (OT's answer to the Sonority Sequencing Principle). Finally, candidate e) fails because by deleting a string-internal segment, it violates CONTIG$_{MAX}$. That leaves (1:6f) (☞) as the most harmonic candidate in the analysis. Of course, the actual output is (1:6e), so the analysis itself fails (💣). Moreover, the success or failure of the analysis is not dependent upon the ranking of the constraints, since the set of violations triggered by (1:6f) is a proper subset of the set of violations triggered by (1:6e), and therefore candidate (1:6e) can never best candidate (1:6f), whatever the constraint ranking may be.

This situation is known in the literature of GP (e.g. Kiparsky 1971) as an instance of *opacity*. The most comprehensive expression of opacity I have seen is by Idsardi (2000):

> An opaque generalization is a generalization that does crucial work in the analysis, but which does not hold of the output form.

Under such a broad definition, opacity can derive from more than one type of source. For example, Idsardi (2000) points out that under lexical phonology (Kiparsky 1982), rules can apply in derived environments in such a way that they are opaque at the surface in non-derived environments. Examples of opacity can also arise from the OT paradigm, since constraints can do crucial work in an analysis, but at the same time can be violated, and hence not hold of the output form. Of course, the instance of opacity under investigation here – deletion of the glide /j/ wherever it cannot be syllabified – is of the rule-ordering type, which is strongly associated with GP.

There are two kinds of rule-ordering opacity, overapplication and underapplication, and (1:6) involves the former. A rule is said to overapply whenever its application is non-surface apparent. That is, it appears on the surface that the rule should not have applied even though it did in fact apply. Overapplication occurs when a rule $\mathfrak{R}_2$ erases the structural description of another rule $\mathfrak{R}_1$ *after* $\mathfrak{R}_1$ has already applied. With the structural description of $\mathfrak{R}_1$ gone, there seems to be no reason (at the surface) for $\mathfrak{R}_1$ to have applied. Put differently, overapplication results from a counterbleeding relationship between two rules, wherein one rule ($\mathfrak{R}_2$ in this case) would have bled another (here $\mathfrak{R}_1$) if $\mathfrak{R}_2$ had preceded $\mathfrak{R}_1$. The fact that $\mathfrak{R}_2$ actually follows $\mathfrak{R}_1$ has two consequences: first, $\mathfrak{R}_1$ does apply, and second, it seems as though $\mathfrak{R}_1$ should not have applied. That is, $\mathfrak{R}_1$'s application is non-surface apparent.

In the case of *bylur*, the nominative singular form of 'snowstorm', $\mathfrak{R}_1$ is the Glide Deletion Rule, while $\mathfrak{R}_2$ is the [ʏ]-Epenthesis Rule, as shown in (1:7) - originally presented above as (1:2).

(1:7) Glide deletion and [ʏ]-epenthesis rules, adapted from Orešnik (1972a); both rules derive from work done by Benediktsson (1969) on Old Icelandic.

Underlying Form ..../pɪlj+r/ → /pɪljr/

$\mathfrak{R}_1$: Glide Deletion................../pɪljr/ → /pɪlr/

$\mathfrak{R}_2$: [ʏ]-Epenthesis................../pɪlr/ → /pɪlʏr/

Output..[pɪlʏr]

Seen from a GP, ordered-rule perpective, the situation is straightforward. The Glide Deletion rule ($\mathfrak{R}_1$) applies because its structural description [+cons, +high]

{C, #} is satisfied by the underlying sequence /...jr/. Then the [ʏ]-Epenthesis Rule ($\Re_2$) applies because its structural description C + r {C, #} is satisfied by the intermediate representation /...lr/, which itself is the output of $\Re_1$. Once $\Re_2$ has applied, there no longer remains any trace of $\Re_1$'s structural description, but that fact causes no problems for the GP analysis. Nevertheless, as (1:6) demonstrates, a standard OT analysis is stymied.

1.2.3 Sympathy as a solution to opacity

Several attempts have been made to address the concept of opacity within the context of OT. Sympathy (McCarthy 1999a) is one such approach. The idea behind sympathy is that, in an opacity situation, the most harmonic candidate C☞ (see (1:6f) above) does not surface because the candidate that *does* surface C💣 (see (1:6e) above) bears a certain kind of "sympathetic" resemblace to a failed candidate C❀, which is termed the *sympathy* candidate (the flower symbol ❀ is used in the literature to represent sympathy).

In order to determine the identity of the C❀, it is first necessary to find a constraint that is violated by both C☞ and C💣, and is not violated by at least one other candidate. In (1:6), the only such constraint is DEP-IO, so DEP-IO is designated the sympathy constraint, and henceforth is written DEP-IO❀. The next step is to determine, among all the candidates that satisfy DEP-IO❀, which one is the most harmonic, i.e. incurs the least onorous constraint violations overall. That will be designated $C_{❀}$, the sympathy candidate. In (1:6), candidates (1:6a), (1:6b), (1:6c), and (1:6d) all satisfy DEP-IO❀. Candidates (1:6b), (1:6c) and (1:6d) are nevertheless eliminated because they all violate the highest-ranked constraint, SONCON, while a) does not. Therefore, (1:6a) is the sympathy candidate.

The next step in the sympathy process is to establish a faithfulness relation with the $C_{❀}$. This is done by coining a new faithfulness constraint that requires correspondence between the output candidate $C_{💣}$ and the sympathy candidate $C_{❀}$. The new constraint must be based on the sympathy constraint, so for the example in (1:6), where the sympathy constraint is DEP-IO❀, the new constraint is DEP-❀O.

DEP-❀O: *Each segment in the output has a correspondent in the ❀-candidate.*

Finally, the new constraint DEP-❀O must be ranked in such a way that (1:6e), /pɪlʏr/, which was the actual output candidate ($C_{💣}$) that caused the pre-sympathy analysis to fail in (1:6), will emerge as most harmonic. That ranking, as it turns out, falls between REALIZE-M and CONTIG$_{MAX}$. Now we have all the elements necessary to construct a sympathy tableau: the sympathy constraint DEP-IO❀, the $C_{❀}$ (candidate (1:6a), /pɪl/), the new faithfulness constraint DEP-❀O and the ranking of that constraint.

(1:8) Sympathy analysis of /pɪlj/ + /r/. The symbol "☞" indicates the most harmonic candidate; the symbol "❀" indicates the sympathy candidate.

/pɪlj + r/	SONCON	REALIZE-M	DEP-❀O	CONTIG$_{MAX}$	DEP-IO$^{❀}$	ANCHOR-R	MAX-IO
a) ❀ pɪl		*!				*	**
b) pɪlj	*!	*	*			*	*
c) pɪlr	*!		*	*			*
d) pɪljr	*!		**				
e) ☞ pɪlʏr			**	*	*		*
f) pɪljʏr			***!		*		
g) pɪljʏ		*!	**		*	*	*

The new tableau, again based on Karvonen & Sherman (1997a), is shown in (1:8). The sympathy candidate, (1:8a), has three segments. Candidate (1:8e) has five segments, two more than the sympathy candidate, and thus incurs two violations of DEP-❀O. Candidate (1:8f) has six segments, and so incurs three violations DEP-❀O. Candidate (1:8f) therefore fails, allowing the candidate that actually surfaces (1:8e) to be the most harmonic.

1.2.4 Problems with sympathy

Several troublesome issues have been associated with sympathy. Here I will touch on only one such problem – a phenomenon called chaos – and then I will conclude this subsection by mentioning and providing references for some other sympathy-related quandaries reported in the literature.

Chaos (Idsardi 1997, who refers to Holden 1986) results from a sympathy analysis whenever such an analysis solves a problem with opacity, but by doing so it causes a misanalysis of non-opaque data. An example of this type of chaos follows from (1:6), (1:7) and (1:8), and is illustrated in (1:9) and (1:10).

(1:9) OT analysis of /pɪlj/ + /ɣm/ (snowstorm + dative plural) using constraints elaborated in (1:6). There are fewer candidates here than in (1:6) because epenthesis is irrelevant (the /ɣ/ is underlying in the dative plural affix). No opacity is involved.

/pɪlj + ɣm/	SONCON	REALIZE-M	CONTIG$_{MAX}$	DEP-IO	ANCHOR-R	MAX-IO
a) pɪl		*!			*	*
b) pɪlj	*!	*			*	
c) pɪlɣm			!*			*
d) ☞ pɪljɣm						

In (1:9), the deletion of the case-assignment morpheme /ɣm/ violates REALIZE-M, causing candidate (1:9a) to fail. Candidate (1:9b) fails because its coda cluster does not fall in sonority, thereby violating SONCON. Finally, candidate (1:9c) fails because by deleting a string-internal segment, it violates CONTIG$_{MAX}$. That correctly leaves (1:9d) (☞) as the most harmonic candidate, with no constraint violations.

This is the expected result. It should also be expected that sympathy tableau (1:8), when supplied with the same data as in (1:9), will designate the same form – [pɪljɣm] – as maximally-harmonic. But this does not happen, as is shown in (1:10).

(1:10) OT analysis of /pɪlj/ + /ʏm/ (snowstorm + dative plural) using constraints elaborated in (1:6) and (1:8). The symbol "☞" indicates the most harmonic candidate, while "❀" indicates the sympathy candidate, and "💣" indicates the candidate that actually surfaces, despite its status as non-optimal.

/pɪlj + ʏm/	SONCON	REALIZE-M	DEP-❀O	CONTIG$_{MAX}$	DEP-IO❀	ANCHOR-R	MAX-IO
a) ❀ pɪl		*!				*	*
b) pɪlj	*!	*	*			*	
c) ☞ pɪlʏm			**	*			*
d) 💣 pɪljʏm			***				

The sympathy candidate, (1:10a), has three segments. Candidate (1:10c) has five segments, two more than the sympathy candidate, and thus incurs two violations of DEP-❀O. Candidate (1:10d) has six segments, and so incurs three violations of DEP-❀O. Candidate (1:10d) thus fails, which leaves (1:10c) (☞) as the most harmonic candidate. Of course, the actual output is (1:10d), so despite the absence of opacity in the data, the analysis fails (💣). This is chaos.

There exist additional reasons for questioning the usefulness of sympathy in handling problems related to opacity, but I will only mention them in passing. For example, Idsardi (2000) suggests that some sympathy analyses in Tiberian Hebrew (McCarthy 1999) can deal with overapplication opacity, as was the case in (1:8) above, but cannot handle underapplication opacity - the type that involves counterfeeding among rules, leading to generalizations that are non-surface-true. Kager (1999) also points up problems with underapplication in the context of chain-shift analyses in the Extarri dialect of Western Basque (Kirchner 1996).

The method used to develop a sympathy analysis is itself problematic, because in order to avoid circularity in the selection of a sympathy candidate, the sympathy constraint must be opaque to the selection process (Kager 1999). This requirement results, within a single analysis, in two mutually-exclusive sub-tableaux: one that selects the sympathy candidate, and another that selects the output candidate. Such an architecture is of course stipulative and non-explanatory.

To conclude this section: optimality theory is a model of universal constraints that excludes intermediate representations. Languages differ only in the ranking of the constraints. Opponents of OT standardly criticize optimality for its inability to process certain types of opacity. In response, optimality theorists have proposed sympathy as a means for handling opaque generalizations. Sympathy has been shown to present its own problems, however, including limitations on the scope of its application, a tendency to engender chaos effects, and stipulative invisibility of sympathy structures.

Nevertheless, optimality theory remains a major force in phonology, and has even been brought to bear successfully on problems in syntax, despite its apparent shortcomings.

1.3 Dynamic Phonology

Dynamic Phonology (henceforth DP: Calabrese 1988, 1995, 2002, 2003, 2004) is a theory under development. It makes use of both rules and constraints, and in so doing, it represents an improvement over OT because it can handle rule-order opacity, and it represents an improvement over GP because it is able to encode conspiracy. Both of these capabilities will be demonstrated in this section.

As the theory now stands, DP is characterized by its focus on *efficiency in a real-world environment*. "The conversion of underlying representations into surface ones is a real time computation which must be implemented efficiently from the point of view of time and means" (Calabrese 2004:15). This means that, under DP, phonological processes are shaped by the principles of cause and effect within the confines of space and time, just like any other human behavior. DP cannot accommodate purely theoretical constructs such as infinite sets or perpetual algorithms that exist nowhere outside the realm of imagination. The act of doing something - whether accessing a lexical item, or mapping a phonological representation onto an articulatory representation - always requires an actual expenditure of time and energy. That expenditure, in turn, is always subject to conditions of relative efficiency such that the most efficient process will prevail, and the output that results from the most efficient set of processes will surface.

1.3.1 Relative Efficiency

To exemplify the concept of relative efficiency, I will compare rule-based GP with constraint-based OT using the simple phonological process of coda consonant devoicing in Dutch, and show that while the same result surfaces in both theories, a rule is more efficient in this case.

The coda devoicing rule for Dutch is shown in (1:11).

(1:11) GP rule, Dutch coda devoicing

$[-\text{sonorant}, +\text{voice}] \rightarrow [-\text{voice}] \;/\; \_\__{\sigma}$

The GP rule in (1:11) accomplishes its task by means of a focus ([-son , +voice]), a structural change (→ [-voice]), and an environment specification ($\_\__{\sigma}$). With an input of /bɛd/, for example, the output would be [bɛt]. By contrast, the OT tableau required for Dutch coda devoicing is shown in (1:12).

(1:12) OT tableau, Dutch coda devoicing (adapted from Kager 1999:16)

/bɛd/	*VOI-CODA	IDENT-IO(VOI)
[bɛd]	*!	
☞ [bɛt]		*

The constraint *VOI-CODA militates against voiced codas, and is violated in the tableau by [d]. The constraint IDENT-IO(VOI) requires that the input coda consonant /d/ remain unchanged, and is violated in the tableau by [t].

As mentioned in the section on OT above, (1:12) must have recourse to the following processes and constructs:

- GEN (which yields an efficiency-busting infinite output)
- ranking of constraints (whether or not they are germane to the analysis)
- the application of EVAL

EVAL itself must take into account the content of the individual constraints, the ranking that obtains among those constraints, and the success or failure of the candidates as measured against the content of the constraints alone (in the case of markedness constraints such as *VOI-CODA) as well as the success or failure of candidates when measured against the content of the constraints *and* the structure of the input (in the case of faithfulness constraints such as IDENT-IO(VOI)).

The above comparison of (1:11) and (1:12) shows what an efficiency competition between two theories could look like, and it suggests that GP, with its single rule composed of just three constituents, is more efficient than OT in the context of a simple phonological process, in this case consonant devoicing in Dutch; it is nevertheless possible that OT could be shown to be more efficient than GP given another (presumably more complex) set of data. The point here is that phonological processes *can* be compared in terms of efficiency, and uncontroversial efficiency judgments are available to the analyst.

How can efficiency be quantified in terms of phonological processes? Calabrese (2004) suggests that the most efficient operation would embody the characteristics listed in (1:13).

(1:13) Efficiency precepts required under Dynamic Phonology

a) minimum use of maximally relevant structural elements
b) minimum use of maximally relevant complexity
c) minimum use of maximally relevant operations

Under these standards, OT with its constraints appears not to compete successfully with the GP rule-based approach to phonology. For one thing, there is only a single type of rule in (1:11), thereby satisfying (1:13a), which requires minimum use of structural elements; by contrast, (1:12) cannot do without two types of constraints. Then again, the boundless output of GEN inherent in (1:12) clearly violates precept (1:13b), which requires the minimum use of complexity, whereas (1:11) is not subject to the ever-spreading implications of infinity. The rule in (1:11) is also more efficient in terms of (1:13c), the minimum use of operations, since the structural change is the sole operation, whereas in (1:12) there are three: the single GEN operation, and the two EVAL operations.

Given the above efficiency competition, it might seem desirable to conclude that rules are always more efficient than constraints. However, not all comparisons between rules and constraints involve processes that are as basic as coda devoicing, and not all constraint-based models are saddled with the inefficiencies evidently borne by OT.

1.3.2 Constraints and Repairs

As mentioned, Dynamic Phonology does make use of constraints, specifically in order to account for phonological conspiracies. Instead of the OT approach, however, DP makes use of an efficiency-regulated constraint-and-repair paradigm. Repairs to violations of constraints can take any form, as long as they only involve the addition or deletion of association lines (e.g. add or delete syllabic lines, syllabic nucleus positions, or skeletal positions), or the addition or deletion of features and their values. This includes *negation*, or switching the value of a feature, for example [+nasal] → [-nasal] or [-ATR] → [+ATR]. The overriding formula - *maximum relevance, minimum use* - involves the precepts listed in (1:13), as well as the following suggestions from Calabrese (2003):

- an output with fewer syllables is preferred over one with more syllables
- an output with simpler syllable structure is preferred over one with more complex syllable structure
- markedness and complexity add cost to a given configuration

Therefore it is possible that more than one repair will be available to correct the violation of any given constraint. The most efficient repair will be tried first, and only if that repair fails will subsequent available repairs apply. Efficiency ranking among repairs is attributed in the model to UG, so that if Repair A precedes Repair B in one language, Repair A will precede Repair B in all languages. This does not mean that Repair A will succeed in all languages; language-specific idiosyncracies could cause Repair A to fail, resulting in the application of Repair B. In such cases, under the DP model, whenever Repair B is seen to have resolved a constraint violation, it should always be possible to show that Repair A has somehow failed. Certain universal constraints, such as *[+high, +low] are not subject to repair; these are called *prohibitions.*

An earlier version of DP (Calabrese 2003), elements of which I maintain in this dissertation, permits the grammar to assign *premium value* to a feature or segment. Violation of premium value assignments will reduce economy, and therefore any feature or segment embued with premium value will resist change or deletion. So, for example, if there are two potential repairs to a constraint violation, and one of them would delete a feature or segment that enjoys premium value, then the other repair would apply first.

1.3.2.1 The Hiatus Conspiracy

Mention of conspiracy was made in section 1.1.2 above. A further example, attributed in Calabrese (2004) to Hutchinson (1974), involves hiatus resolution in a casual-speech form of Mexican-American Spanish (henceforth "Chicano").

(1:14) Resolution of [+high, -low][-conson] hiatus, Chicano

Underlying	Surface	Orthographic	Gloss
/tu+ixo/	[twixo]	'tu hijo'	*your son*
/mi+ultima/	[mjultima]	'mi última'	*my last one*

(1:15) Resolution of [-high, -low][-conson] hiatus, Chicano

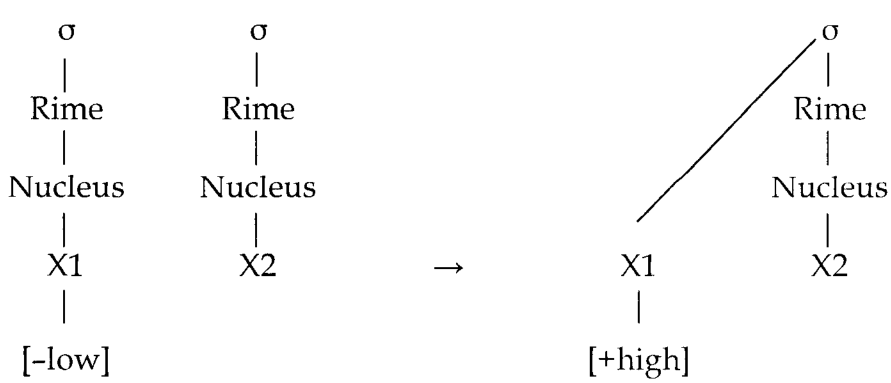
Underlying	Surface	Orthographic	Gloss
/teŋgo+ipo/	[teŋgwipo]	'tengo hipo'	*I have the hiccups*
/me+urxe/	[mjurxe]	'me urge'	*I am compelled*

(1:16) Resolution of [-high, +low][-conson] hiatus, Chicano

Underlying	Surface	Orthographic	Gloss
/esta+ixa/	[est_ixa]	'esta hija'	*this daughter*
/la+iɣlesja/	[l_iɣlesja]	'la iglesia'	*the church*

The process exemplified in (1:14) and (1:15), glide formation, is characterized in (1:17).

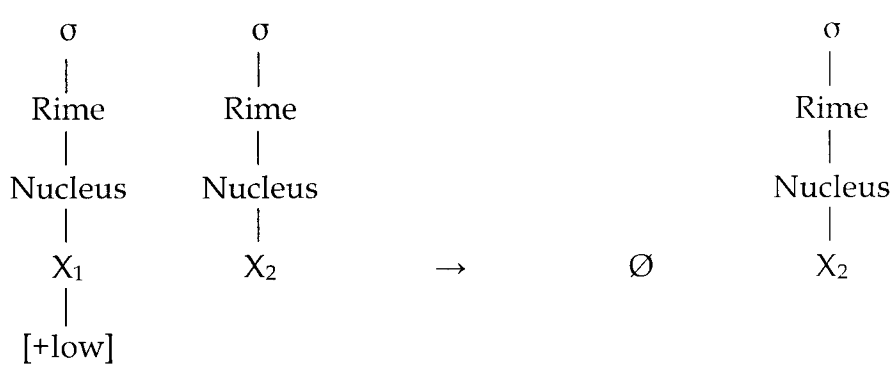
(1:17) Glide formation in Chicano hiatus, initial vowel [-low]



(1:17) is a rule that changes the sequence of vowels on the left side of the arrow to the glide-vowel sequence on the right side of the arrow. This rule applies when the first vowel in the sequence is [-low].

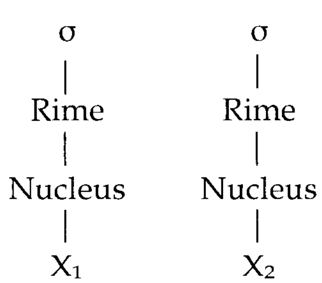
The process exemplified in (1:16), deletion, is characterized in (1:18).

(1:18) Deletion in Chicano hiatus, initial vowel [+low]



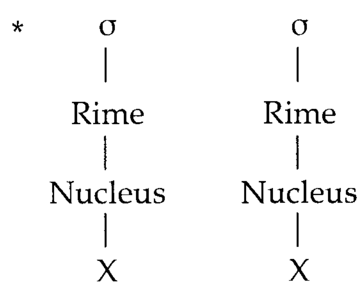
The obvious problem when comparing (1:17) with (1:18) is that both rules share the structural description shown in (1:19).

(1:19) Structural description common to both Chicano hiatus rules



Neither the glide formation rule nor the deletion rule provides any explanation for the shared structural description, which shows that a generalization eludes this rule-based analysis. That generalization is most succinctly expressible as the constraint in (1:20).

(1:20) The NoHiatus constraint.



In DP, a constraint such as (1:20) carries with it a set of possible repair mechanisms that comes into play whenever the constraint is violated. If the set contains more than one repair mechanism, then these mechanisms apply in an order that is determined by UG. Only if the top-ranked repair mechanism fails will the next-ranked repair mechanism apply; if that also fails, then the next available repair mechanisms will apply in sequence, according to their UG-determined ranking, until either the repair is successful or all the repair mechanisms have failed. In that case, the input will surface despite its constraint violation.

Based on empirical evidence, Calabrese (2004) suggests that hiatus is disallowed in many languages including Chicano, that the disallowance of hiatus is expressible as the constraint in (1:20), and that there exists a set of repair mechanisms associated with (1:20) which are ranked in accordance with UG. Those mechanisms and their rankings are shown in (1:21).

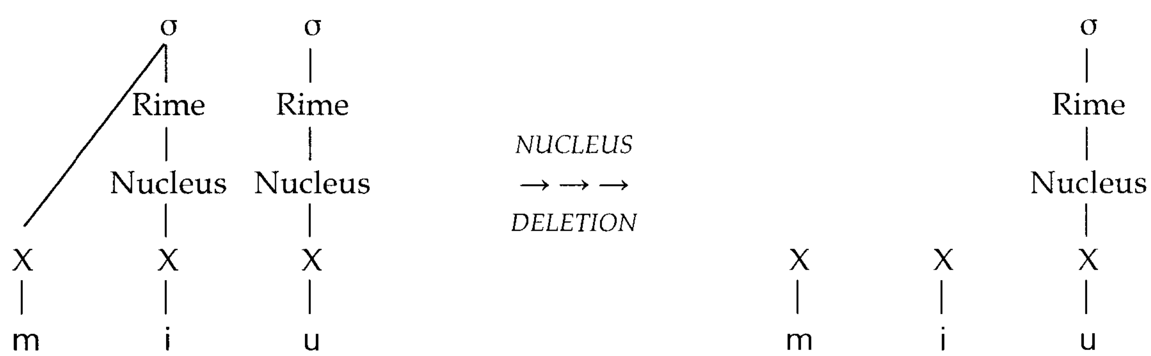
(1:21) Repair mechanisms associated with NoHiatus, ranked by UG.

a) Glide formation
b) Vowel deletion
c) Segment insertion
d) None of the above (complete repair failure)

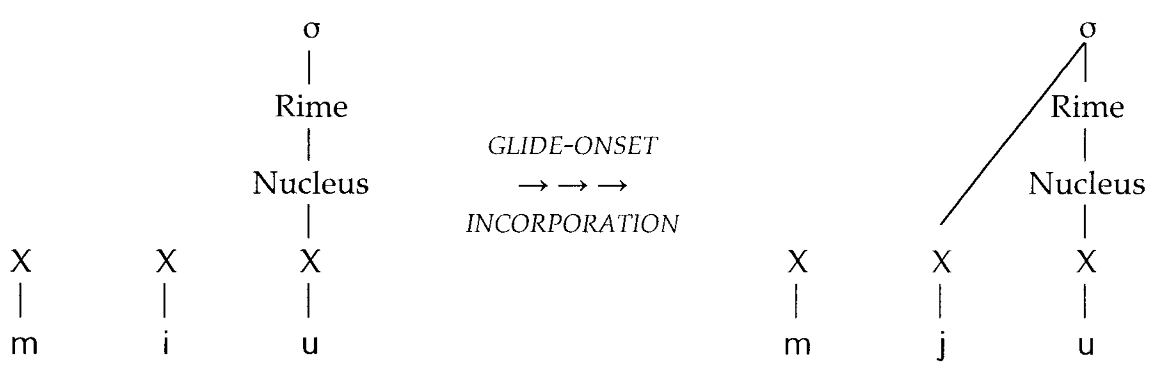
In Chicano, whenever the NOHIATUS constraint is violated, either glide formation takes place, as mentioned in (1:14), (1:15) and (1:17), or a vowel is deleted, as referenced in (1:16) and (1:18). Segment insertion never results, nor does there occur a failure of all repair mechanisms (which would allow the violation to surface). Therefore, according to the tenets of DP, there must be a reason why (1:21a), glide formation, successfully repairs some but not all the violations of the NOHIATUS constraint, and why (1:21b), vowel deletion, successfully repairs all the NOHIATUS violations that were missed by (1:21a). If these two questions are answered satisfactorily, then it follows from the model that (1:21c) and (1:21d) need not come into play, and no further explanation is necessary with respect to segment insertion or repair failure.

Following Calabrese's analysis, glide formation becomes directly available as a repair mechanism when the first of the two vowels involved in a hiatus situation is [+high], as exemplified in (1:14). Glide formation is essentially a nucleus-deletion operation, with subsequent (re)incorporation of any unattached segments as onsets. To demonstrate this process, the glide formation mechanism is applied in (1:22) to the first three segments of 'mi última', where the initial vowel of the hiatus sequence is [+high].

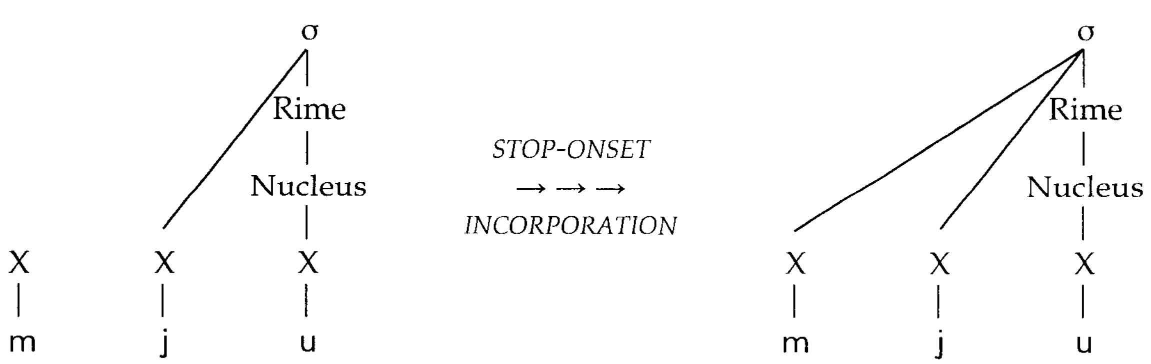
(1:22a) Glide formation, first vowel [+high]: nucleus deletion



(1:22b) Glide formation, first vowel [+high]: onset incorporation (glide)



(1:22c) Glide formation, first vowel [+high]: onset incorporation (stop)



(1:22a) depicts nucleus deletion, (1:22b) shows incorporation of the former nuclear vowel as part of the onset (hence a glide), and (1:22c) shows incorporation of the stop as the lead segment of the onset cluster.

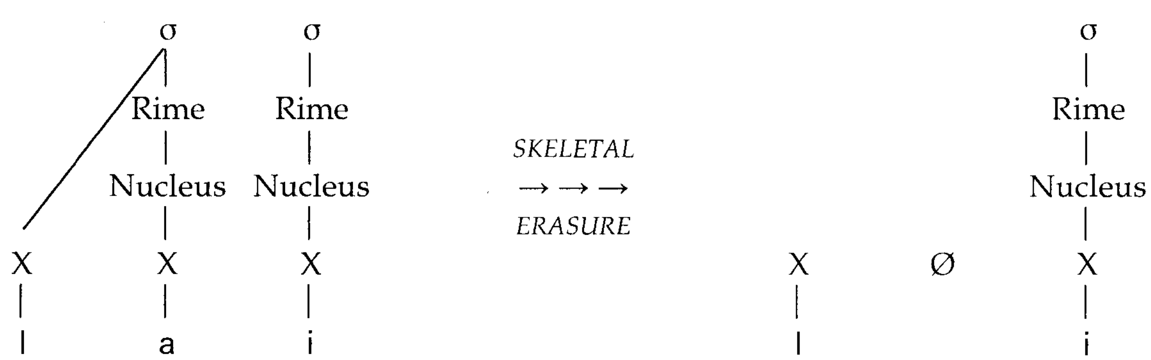
Although (1:22) works for hiatus situations where the first vowel is [+high], glide formation cannot take place - or at least not in quite so straightforward a manner - when the first hiatus vowel is not [+high]; two examples of this situation were shown in (1:15). In such a circumstance, (1:22) fails to achieve the repair because non-high glides do not occur in any language, and the mechanisms in (1:22) do not include raising. Instead, Calabrese posits a constraint that prohibits non-high vowels in onset or coda position. This constraint is called NO[-HI]INSYLLMARG, and it licenses a repair mechanism that raises the offending vowel to [+high], thus allowing glide formation (1:22) to complete the repairs needed for the examples mentioned in (1:15).

This leaves (1:16), the set of hiatus pairs whose initial member is characterized by [-high, +low]. This configuration (specifically, [-high]) violates NO[-HI]INSYLLMARG, thereby triggering the raising repair described immediately above. That repair cannot be implemented, however, because its implementation would result in a [+high, +low] segment, which is disallowed by the universal prohibition *[+high, +low], which itself is not subject to repair. The assumption here is that NO[-HI]INSYLLMARG is associated with only one repair mechanism –

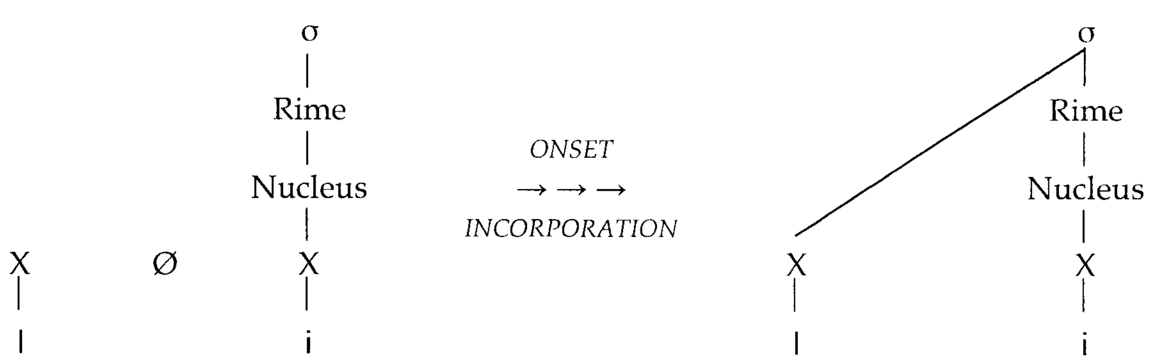
raising. When the raising repair fails, then, that failure keeps glide formation from taking place.

With the failure of glide formation (1:21a), the model moves on to the next available repair, which is vowel deletion (1:21b), a process that involves skeletal erasure and onset incorporation. To demonstrate, the vowel deletion mechanism is applied in (1:23) to the first three segments of 'la iglesia', where the initial vowel of the hiatus sequence is [+low].

(1:23a) Vowel deletion, first vowel [+low]: skeletal erasure



(1:23b) Glide formation, first vowel [+low]: onset incorporation



To sum up, Chicano hiatus is resolved in three different ways, depending on the values of the height features of the first vowel in the pair. When the initial constituent of the hiatus is [+high, -low], as exemplified in (1:14), a three-stage glide formation process (1:22) serves as a repair mechanism for the NOHIATUS constraint (1:20).

When the first constituent of the hiatus is [-high, -low], as shown in (1:15), the negative value of the feature [high] violates NO[-HI]INSYLLMARG, necessitating a repair that changes the feature value from minus to plus; this raising repair results in the configuration [+high, -low], which then undergoes glide formation (1:22) as a repair for NOHIATUS.

Finally, when the first constituent of the hiatus is [-high, +low], as shown in (1:16), the negative value of the feature [high] again violates NO[-HI]INSYLLMARG, triggering the raising repair. The raising repair fails, though, because its success would result in the prohibited configuration [+high, +low]. This situation causes the glide formation repair to fail, so the model invokes the next possible repair from those available in (1:21), which is vowel deletion.

It is notable that this analysis - and DP as it now stands - relies on a binary theory of vowel features. Not all phonologists agree that all features must have either a plus value or a minus value, and if it can be shown conclusively that the binary approach to vowel features is inadequate, then the architecture of DP would have to change to accommodate that finding.

1.3.3 Constraints versus Rules

Mixing rules with constraints in a single theory has been discredited as undesirable, perhaps most notably in The Minimalist Program:

> The worst possible case is that devices of both types are required: both computational processes that map symbolic representations to others [i.e. rules] and output conditions [i.e. constraints].
>
> — *Chomsky (1995:223); square brackets added.*

The argument goes that rules and constraints are logical equivalents (see Mohanan (2000) for an illustration of this perspective), and therefore the use of both constructs is inherently redundant. The rule [+voice] → [-voice] / $\_\__{\sigma}$ and the constraint *VOI-CODA may indeed seem to be different expressions of the same thing, and if they are employed in identical fashions it could be successfully argued that they *are* the same.

Under DP, rules and constraints do have one thing in common, in that both can be universal or language-specific. For each language, a unique set of language-specific rules and constraints is active, while all other language-specific rules and constraints are deactivated (via suppression in the acquisition process).

However, rules and constraints can never be logically equivalent, or mirror images of each other. This is because all rules, for example A → B / __ C, carry within them both the statement of the problem, in this case the unstable environment AC, as well as the solution to that problem, here A → B. That is the only possible solution, and it yields only one possible outcome: BC.

DP constraints differ from rules crucially in that while they do contain within them the statement of the problem, for example *AC, they do not specify the solution to that problem. In other words, while the rule A → B / __ C can only be satisfied by an output of BC, the constraint *AC can be satisfied by any output, as long as it is not AC. As discussed above, the output that arises from a constraint violation is determined by a set of UG-ordered repair mechanisms which is independent of the constraint that invokes it.

1.3.4 Rules in DP

Whereas constraints are associated with conspiracy effects, rules can account for "natural processes" such as syncope, epenthesis, devoicing, and assimilation "in which the target configuration appears to be treated in the same way across languages" (Calabrese 2004:26). Rules are also necessary for expressing instances of feeding, counterfeeding, bleeding, and counterbleeding.

In addition, rules are crucial for explaining "historical baggage," or phonological processes that evolved from a sequence of changes whose traces have vanished over time. An example of such a process is Polish Raising, expressed as the rule in (1:24).

(1:24) Polish Raising rule, adapted from Kenstowicz 1994:77.

[–high, +round] → [+high] / __ [+cons, +voice, –nasal].#

The Polish Raising rule is not a "natural" one, in that there is no particular reason why /o/ should surface as [u] before voiced oral consonants. Its existence can be attributed to the sequence of rules listed in (1:25).

(1:25) Diachronic changes leading up to Polish Raising, Calabrese (2004:5)

a) Lengthening before voiced, non-nasal coda consonants
b) Context-free raising of long vowels
c) Shortening of long vowels

The elimination in the past of long vowels via (1:25c) wiped out all trace of (1:25a) and (1:25b), resulting in a kind of diachronic opacity that makes the Polish Raising rule appear unmotivated; and as far as a first-language learner of Polish is concerned, the rule in (1:24) is indeed arbitrary, idiosyncratic and unmotivated, and must be learned by rote.

1.3.4.1 Acquisition and Deployment of Rules

There are three abilities involving rules, but not associated with UG, that the language learner must develop in order to achieve competence in phonological processes. The first skill is memorization, which is necessary for the acquisition of instances of synchronic opacity such as the Polish Raising rule. The ability to memorize is also an integral part of the process of storing lexical items, and is vital for learning lexical exceptions.

The second skill is a capacity to perform extrinsic rule ordering, that is, rule ordering that is not based on universal principles. Such an ability is needed to handle cases of opacity involving counterbleeding – an example of which was examined at length in §1.2.2 – as well as counterfeeding.

The third skill is an ability to carry out intrinsic rule ordering. This is needed to handle examples of feeding, where rule A feeds rule B if the output of A creates the environment for the application of B, and bleeding, where rule A bleeds rule B if the output of A eliminates the environment for the application of B. Intrinsic ordering is associated with universal principles, and thus should be available to any normal language learner.

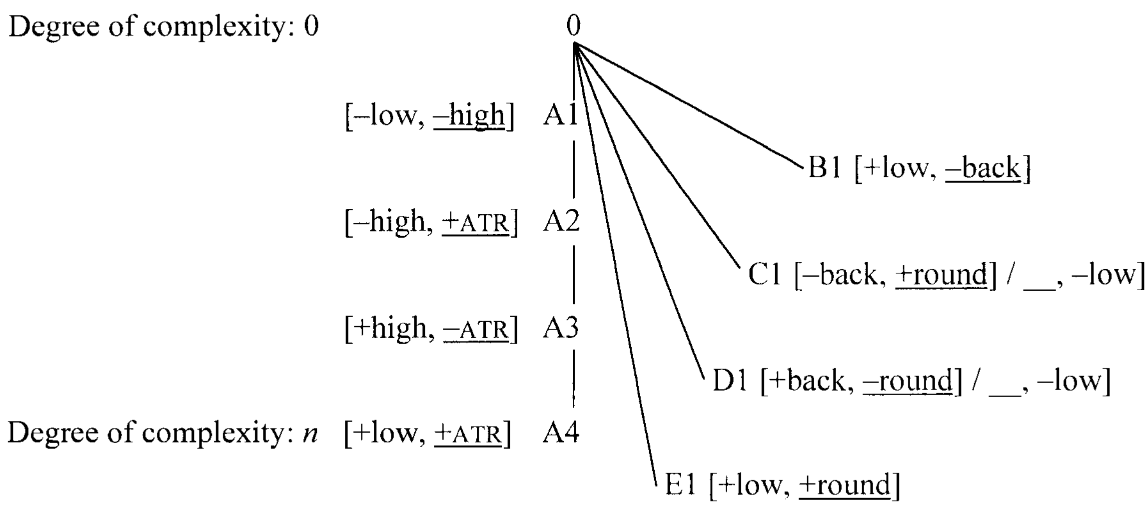
1.3.5 Marking Statements

Constraints such as NOHIATUS or [–consonantal, +nasal], which militates against nasal vowels, are considered *marking statements.*

The marking statement [–consonantal, +nasal] can be read as "If minus-consonantal, then *not* plus-nasal", with the underscoring of the second element meaning "disfavored" or "marked." Whenever that particular marking statement is active in a language, then nasal vowels will be non-contrastive in that language. Where nasal vowels are contrastive, as in French and Portuguese for example, the marking statement [–consonantal, +nasal] is understood to have been deactivated during the acquisition process. Otherwise, as in Icelandic, [–consonantal, +nasal] is active.

Marking statements can occur in isolation or as part of a hierarchical structure involving varying degrees of complexity. "Complexity" in this context refers to a relative lack of articulatory and/or acoustic efficiency, or in other words, markedness. To illustrate, I refer to the vowel chart in Calabrese (1995:381), presented here as (1:26).

(1:26) Calabrese's (1995:381) marking statements germane to vowel systems



The marking statements B1, C1, D1 and E1 occur in isolation. By contrast, the marking statements A1, A2, A3, and A4 exist in a hierarchical relationship such that A2 cannot be deactivated unless A1 is deactivated, A3 cannot be deactivated unless A2 (and therefore A1) is deactivated, and A4 cannot be deactivated unless A3 (and A2 and A1) are deactivated. Calabrese claims that (1:26) accounts for the vowel systems of all human languages. For example, if all of the marking statements are active in a language, then a zero-level of complexity obtains, and only [i], [a] and [u] will occur. This happens in Arabic. Deactivation of A1 results in the inventory [i], [a], [u], [ɛ], [ɔ], which are the vowels of Hawaiian.

Deactivation of B1 yields the vowels [i], [a], [u], [æ] as in Latvian.

In the following chapter I will use Calabrese's system of marking statements in a mostly-successful attempt to analyze the historical development of the inventory of Icelandic vowels. Later I will explore other aspects of Calabrese's model, and apply them to consonant distribution as well as aspiration effects in Icelandic phonology. First, however, I will establish some background for the upcoming chapter on Icelandic vowels.

The distinctive features of many common vowels, including all vowels that occur in Icelandic phonology, are laid out in (1:27).

(1:27) *Distinctive feature grid for some vowels*

	high	low	back	round	ATR
i	+	–	–	–	+
y	+	–	–	+	+
ɪ	+	–	–	–	–
ʏ	+	–	–	+	–
e	–	–	–	–	+
ø	–	–	–	+	+
ɛ	–	–	–	–	–
œ	–	–	–	+	–
ɯ	+	–	+	–	+
u	+	–	+	+	+
ɤ	–	–	+	–	+
o	–	–	+	+	+

	high	low	back	round	ATR
a	–	+	+	–	–
ɶ	–	+	–	+	–
ɒ	–	+	+	+	+
ɑ	–	+	+	–	+
æ	–	+	–	–	–
ʌ	–	–	+	–	–
ɔ	–	–	+	+	–
ʊ	+	–	+	+	–

The following list (1:28) shows the sets of those vowels laid out in (1:27), directly above, that are licensed by the deactivation of the marking statements of (1:26). (1:28) takes into account that it is unmarked for non-high vowels to be [–ATR], and it is unmarked for back vowels to be round.

(1:28) Vowel licensing (i.e. complexity) according to deactivation of marking statements

Zero complexity (no marking statements deactivated): [i], [a], [u]

A1 deactivated: [ɛ], [ɔ] (plus [i], [a], [u])

A2 deactivated: [e], [o] (plus [i], [a], [u], [ɛ], [ɔ])

A3 deactivated: [ɪ], [ʊ] (plus [i], [a], [u],[ɛ], [ɔ], [e], [o])

A4 deactivated: [ɑ] (plus [i], [a], [u], [ɛ], [ɔ], [e], [o], [ɪ], [ʏ], [ʊ])

B1 deactivated: [æ] (plus [i], [a], [u])

C1 deactivated: [y], [ʏ], [ø], [œ] (plus [i], [a], [u])

D1 deactivated: [ɯ], [ɤ], [ʌ], [ɨ] (plus [i], [a], [u])

E1 deactivated: [ɒ], [ɶ] (plus [i], [a], [u]) What (1:28) means is that, for example, unless marking statement A1 is deactivated in a particular language, the vowels /ɛ, ɔ/ cannot occur contrastively in that language. Likewise, the vowels /ɯ, ɤ, ʌ, ɨ/ will only occur in a language that has deactivated marking statement D1. The claim here is that every vowel inventory of every natural language can be captured by the sole mechanism of deactivating some (or none) of the marking statements listed in (1:26). In chapter 2, I will examine this claim in the light of two stages in the recorded history of Icelandic vowels.

Chapter Two

The Icelandic Vowel System

2.0 History, Inventory, Features

To help develop a perspective on why modern Icelandic vowels are marked the way they are, it will be useful to review what we know about how the language has changed from the settlement period which began in 870 AD. Luckily we possess a twelfth-century document, traditionally called the First Grammatical Treatise, that examines in detail Icelandic vowels.

The treatise, whose author's name is unknown, has been analyzed in Haugen (1950, 1972), Benediktsson (1959, 1972), and Albano Leoni (1975), among others. The current chapter is based on the original data as translated and presented by Haugen, plus his and Benediktsson's comments, which analyze the twelfth-century treatise as well as the historical development of the modern Icelandic vowel system. For both stages in the history of the vowel system, I will apply the precepts of Dynamic Phonology in order to test its ability to handle the shifting data.

2.1 The Middle Ages

During a period ranging from the eighth to the beginning of the twelfth centuries, according to the Treatise, twenty-seven contrastive vowel segments existed in Icelandic. These segments are shown in (2:1) where contrastive length is represented by the colon (ː), and nasality is represented by the tilde (~).

(2:1) Inventory of Old Icelandic vowels

Front Unrounded			Front Rounded			Back		
i	iː	ĩː	y	yː	ỹː	u	uː	ũː
e	eː	ẽː	ø	øː	ø̃ː	o	oː	õː
æ	æː	æ̃ː				œ	œː	œ̃ː
						a	aː	ãː

The Treatise is an attempt to codify a spelling system for Icelandic, which the author recognized had diverged from Old Norse in the three hundred years since the Viking colonists arrived from Norway. The author selected, and in the cases of ǫ (= IPA œ) and ę (= IPA æ) adapted, characters from the Roman alphabet in order to represent the sounds of his language, and his work provides obvious clues about how the contrastive vowel segments of Old Icelandic were pronounced. In addition, when trying to describe new Medieval sounds (those that diverged from the vowel inventory of Old Norse), he attempted to establish relationships - e.g. relative openness, combinations, and blending - between the new sounds and those old sounds that he obviously presumed his twelfth-century readership would have been familiar with.

2.1.1 Benediktson's Analysis of the Treatise

Benediktsson (1959) set out to interpret what the Treatise's author had to say about the Medieval vowel system, and re-present that information in terms of this modern phonological framework of the 1950s. That framework is called the Jakobson-Halle feature system (Jakobson and Halle 1956). I present Benediktsson's results, without reference to nasality and length, in (2:2).

The twelfth-century spellings all match today's IPA representations, with the exception of medieval ǫ and ę. Based on Benediktson's 1959 analysis, I contend that ǫ represents the [+low, +round] IPA vowel [œ], while ę represents [æ], which has the features [+low, -round].

(2:2) Jakobson-Halle distinctive feature grid for vowels described in the First Grammatical Treatise, adapted from Benediktson (1959:287)

12th C. spelling	diffuse	compact	grave	flat
i	+	-		-
y	+	-	-	+
e	-	-		-
ø	-	-	-	+
u	+	-	+	+
o	-	-	+	+
a		+	+	-
ǫ = [œ]		+		+
ę = [æ]		+	-	-
21st C. terms	high	low	back	round

The qualities of the first seven vowels in (2:2) is not in contention, although given that [ATR] is not contrastive at any level in this system, I should point out that the vowel spelled "i" could be considered /i/ or /ɪ/ without having any effect on this phonological analysis. By the same token, "y" could be represented as /y/ or /ʏ/, "e" could be seen as /e/ or /ɛ/, "ø" could be /ø/ or /œ/, "u" could be /u/ or /ʊ/, "o" could be /o/ or /ɔ/, and "a" could be /a/ or /ɑ/.

There is no reason not to use common orthographic forms such as 'i' and 'ø' in transcription, but the lack of contrast between /i/ and /ɪ/, /ø/ and /œ/, etcetera, must be borne in mind for the purposes of the DP analysis below.

Orthographic "ǫ" is designated "compact" and "flat," thus corresponding to the [+low, +round] vowel /ɶ/ (or /ɒ/, its less-likely [+ATR] counterpart), while Benediktsson assigns to "ę" the features "compact," "acute," and "natural" (i.e. not "flat"), which corresponds to the [+low, -back, -round, - ATR] vowel /æ/; the combination [+low, +ATR] is highly marked.

2.1.2 DP Analysis of Medieval Icelandic Vowels

If we ignore length and nasality for the moment, translate the Jakobson-Halle feature labels into a modern framework, and recall from §1.3.5 that the zero-complexity segments [i], [a], and [u] are always licensed in DP, the inventory in (2:1) can be captured by deactivating the following marking statements:

(2:3) Marking statements whose deactivation licenses medieval Icelandic vowels

- A1 ([-low, <u>-high</u>], which licenses [ɛ] and [ɔ])
- B1 ([+low, <u>-back</u>], which licenses [æ])
- C1 ([-back, <u>+round</u>] / __, -low], which licenses [y], [ʏ], [ø], and [œ])
- E1 ([+low, <u>+round</u>], which licenses [ɶ] and [ɒ])

Since [ATR] is not contrastive in Medieval Icelandic, licensing [ɛ] and [ɔ] via deactivation of A1 is tantamount to licensing [e] and [o]. It would be possible to make the licensing of [e] and [o] explicit by deactivating A2, but such a step would entail deactivation of A1 in any event, and would represent a pointless loss of efficiency for the analysis. Deactivation of C1 and E1 licenses both plus and minus [ATR] values for the segments involved, but this kind of duplication causes no problems for the analysis. Deactivation of B1 requires no explanation.

2.1.2.1 Nasality and Length are Related

Short nasal vowels do not occur in (2:1). The lack of short nasals could be an arbitrary gap, but it could also result from a phonological process driven by marking statements and premium value assignments. According to Haugen (1972:38), "nasalized vowels go back to earlier forms in which a nasal consonant followed the vowel, while the words with oral vowels do not." This observation suggests that each (long) nasal vowel had been derived from a diachronic process whereby an oral vowel followed by a presumably-tautosyllabic nasal consonant became [+nasal], the Place features of the nasal consonant deleted, and the features of the oral vowel spread to the root node of the former nasal consonant, which retained its nasality. Such a process could be described in terms of DP as follows.

If at some point during the Middle Ages a marking statement against nasal consonants in coda position, i.e. [+consonantal, +nasal / $\_\_{\sigma}$], became active in the language, then an underlying VN_{σ} configuration would require repair. One possible repair might be postconsonantal insertion of an epenthetic vowel, a process known as proparalepsis, which would remove the nasal from coda position.

However, proparalepsis would be a relatively complex process, requiring at the very least the placement of a new timing slot or root node after the nasal, followed by invocation of one or more rules that would provide for the attachment of the node to the prosodic structure, and assignment of a minimal set of features (schwa, for example) to the bare root node. Moreover, since schwa-epenthesis, feature assimilation, and stray erasure are all possible phonological processes in this context, there would have to be some kind of mechanism that makes sure that what happens to the newly-minted root node is indeed schwa-feature insertion, rather than feature-borrowing from an adjacent segment, or skipping the prosodic attachment event and deleting altogether.

A simpler repair to [+consonantal, +nasal / __$_{\sigma}$] would be nasal Negation, that is, changing the value of the [+nasal] consonant to [-nasal]. But since the preceding vowel surfaces as [+nasal], nasalization would somehow have to be reintroduced and attributed to that vowel. It is far from clear how such a process would take place.

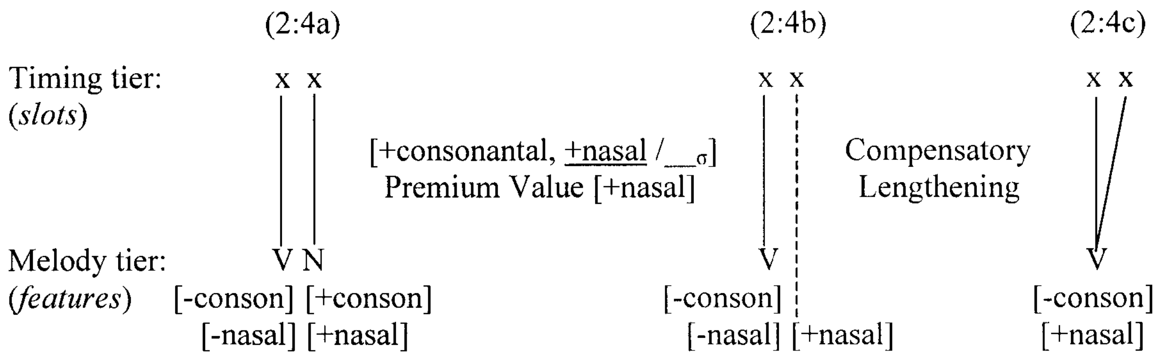
Instead I propose that the feature [+nasal] enjoys a premium value assignment in Medieval Icelandic. When [+consonantal, +nasal / __$_{\sigma}$] is violated by a VN$_{\sigma}$ sequence, then deletion of the consonant takes place; the nasal segment's features are all disassociated from the root node *except* [+nasal], which is protected by the premium value assignment.

Once the nasal consonant (but not its nasality) deletes, compensatory lengthening takes place. Compensatory lengthening refers to the lengthening of a segment in response to the deletion of an adjacent segment. This process can be analyzed in terms of either moraic or segmental models (see Hayes 1989 for discussion), and either approach can be applied within the framework of DP.

My position, developed in chapter four with respect to geminate consonants, strongly supports the segmental approach. Therefore I maintain that delinking some (or all) the features of a segment from a slot on the timing tier triggers the spread of some (or all) features of an adjacent segment to the delinked timing slot. That is the essence of compensatory lengthening.

Figure (2:4) shows how the marking statements of DP would trigger compensatory lengthening under the segmental model, resulting in a long vowel with the feature [+nasal]:

(2:4) Development of a VN sequence into a long nasal vowel via compensatory lengthening under a segmental (non-moraic) model



(2:4a) shows a segment with the features [-consonantal, -nasal] (the oral vowel, which is represented by V) followed by a segment with the features [+consonantal, +nasal] (the nasal consonant, which is represented by N). The markedness statement [+consonantal, +nasal / __σ] combines with the premium value assignment [+nasal] to yield (2:4b), which is a sequence of an oral vowel (V) followed by an incomplete segment that has lost all its features except [+nasal]. Such an incomplete segment cannot surface, so its timing slot is stranded.

This situation invokes compensatory lengthening, whereby the vowel's features spread onto the stranded timing slot. In standard autosegmental phonology, the vowel would then automatically acquire the stranded timing slot's remaining feature [+nasal], which itself had been stranded by the deletion of the nasal consonant. The result is (2:4c), a long nasal vowel - the only source of nasal vowels in old Icelandic. No short nasal vowels could surface under these circumstances, so all nasal vowels are long.

2.1.2.2 Contingent Deactivation is Unstable

Universally, both nasal vowels and long vowels are marked (Ṽ iff V and Vː iff V). Under DP, in order for long nasal vowels to surface in a language, the following two marking statements must be deactivated:

[-consonantal, <u>+nasal</u>]	(no nasal vowels)	DEACTIVATED
*X X \/ [-consonantal]	(no long vowels)	DEACTIVATED

What is interesting about this situation is that, in Medieval Icelandic, these two marking statements are deactivated in tandem; that is, nasal vowels are only licensed when long vowels are licensed. Given the set of data that I am about to present - the inventory of Modern Icelandic vowels - it becomes clear that this tandem deactivation is unstable, and is not resolved until a later generation of

Icelandic children reactivates the marking statement [-consonantal, +nasal], thereby eliminating nasal vowels altogether.

To sum up, Iceland's earliest-known vowel system can be captured with five marking statements (three deactivated and two active) plus one premium value assignment, as shown in (2:5) and (2:6):

(2:5) Deactivated Marking Statements that account for the inventory of medieval Icelandic vowels

- [-low, -high]............................licenses [ɛ] and [ɔ]
- [+low, -back]...........................licenses [æ]
- [-back, +round] / __, -low]....licenses [y], [ʏ], [ø], and [œ]
- [+low, +round]........................licenses [ɶ] and [ɒ]

(2:6) Marking Statements that account for the long (but not short) nasal vowels of medieval Icelandic

a) [-consonantal, +nasal].............deactivated

b) *X X
   \/
[-conson]...................................deactivated

c) [+consonantal, +nasal / __σ]....active

d) [+nasal].....................................premium value

2.2 Modern Icelandic

After the thirteenth century, the set of Icelandic vowels ceased to develop, leaving us the inventory we see in Icelandic today, shown in (2:7).

(2:7) Inventory of Icelandic vowels, present day

Front Unrounded	Front Rounded	Back
i		u
ɪ	ʏ	
ɛ, ʲɛ, ɛʲ	øʲ	oʷ
	œ	ɔ
		a, aʷ, aʲ

In terms of DP, this inventory results from a series of Marking Statement deactivations and reactivations with respect to Old Icelandic, coupled with the introduction of three rules.

2.2.1 Elimination of /ɶː/ and /ɶ/, and of all nasal vowels

One of the most striking differences between Old Icelandic and Modern Icelandic is the latter's lack of /ɶ/, which indicates a reactivation of E1, the marking statement that precludes both /ɶ/ and its [+ATR] variant /ɒ/.

Nasal vowels do not occur in Modern Icelandic. This can be explained as the result of the elimination in Modern Icelandic of the Premium Value that had been assigned to [+nasal] in Old Icelandic. Together with the previously-mentioned Marking Statements against nasals (2:6a) and long vowels (2:6b), which in Modern Icelandic are both active, the lack of Premium Value with respect to [+nasal] eliminates nasal vowels entirely.

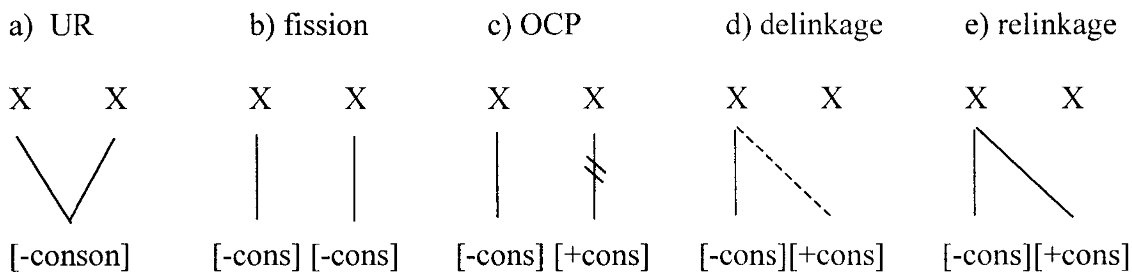
2.2.2 Diphthongization of long vowels

Another sweeping development is the change of Old Icelandic's long vowels into diphthongs in Modern Icelandic. The link between long vowels and glides has been demonstrated in the context of the Great English Vowel Shift (Lehmann 1973), and is also discussed in Hamann (2004), *German vowel shortening and gliding as complementary processes* (non videtur; in preparation). Diphthongization begins with the reactivation of (2:6b) – the Marking Statement that prohibits long vowels.

2.2.2.1 [ø^{j}], [o^{w}] and [a^{w}]

Following the two-root model of geminates, which I discuss at length in Chapter 4, long vowels are represented by a melody attached to two timing units, as shown in (2:8a), below. In Modern Icelandic, Marking Statement (2:6b) entails a repair requirement for (2:8a), which I propose is satisfied by fission at the melody level (2:8b). This, however, results in a violation of the Obligatory Contour Principle. The OCP is a well-attested constraint in phonology (Leben 1973, Goldsmith 1976). I contend that in Calabrese's model the OCP violation causes the second segment's [-conson] feature to undergo Negation, yielding (2:8c). Loss of contrastive vowel length leads to delinkage of the second segment's melody (2:8d) and subsequent relinkage to the first segment's root node, resulting in a glide (2:8e).

(2:8) Diphthongization in Icelandic: Vː → V^G



The long vowel's value for the feature [back] remains with the glide, and thus determines whether the glide surfaces as a front [^{j}] or a back [^{w}]. In this way, /øː/ becomes [ø^j], /oː/ becomes [o^w], and /aː/ becomes [a^w].

2.2.2.2 [i] and [u]

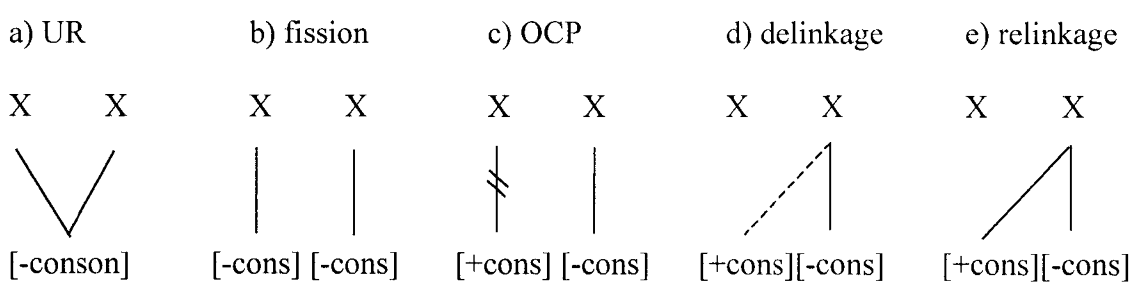
The explanation laid out in §2.2.2.1 does not account for [i] and [u], which existed as /iː/ and /uː/ in Old Icelandic, but do not surface as diphthongs in Modern Icelandic. The reason for this, I suggest, is that the constituent elements of *[i^j] and *[u^w] are too similar. Since the glides [^{j}] and [^{w}] are respectively "brief versions of [i] and [u]" (Trask 1996:157), their adjacency would violate the OCP – at least on a language-specific level – and require repair. To effect that repair, the association lines connecting [ʲ] and [ʷ] to the phonological structure are deleted, so those sounds do not surface.

2.2.2.3 [ʲɛ] and [ɛʲ]

The occurrence in Modern Icelandic of [ʲɛ] requires explanation, since in this diphthong the glide is the first element, whereas in all other diphthongs the glide is the second element. I contend that the diphthong [ɛʲ] already existed at the time when derived diphthongs were replacing long vowels in the language.

I stipulate here that the pre-existence of [ɛʲ] blocked the process */ɛː/ → [ɛʲ]; instead, the changes described in (2:8c), (2:8d), and (2:8e) apply to the melody associated with the *first* node of the fissioned long vowel rather than the second node, resulting in [ʲɛ]. This operation is shown in (2:9).

(2:9) Alternate diphthongization in Icelandic: V: → ^{G}V



Of course, such a stipulation requires an argument to motivate the mechanism by which blocking – rather than, say, merger or chain shift – would occur. I offer no such argument in this dissertation, and the issue remains unresolved here.

2.2.2.4 [a^j]

Another diphthong that requires further comment is [a^j], since the base vowel [a] is [+back], yet the glide [^{j}] is [-back]. I propose that [a^j] derives from /æ^j/, which itself is a diphthongization of the front vowel /æː/. Marking Statement B1, [+low, -back], blocks [æ] from surfacing. Once B1 is reactivated in Modern Icelandic, therefore, /æ^j/ requires repair. The segment could delete, but instead it undergoes Negation of its [-back] feature to become [+back], and so surfaces as [a^j]. This state of affairs predicts that Negation is less complex a repair than the deletion of an association line.

Although the approach works for long /æː/ → /æ^j/ → [a^j], the same repair fails for short /æ/, since the target [a] already exists, so /æ/ cannot become [+back]. Therefore short /æ/ disappears altogether via association-line deletion; in essence, /æ/ merges into [a]. This is another example of the potentially-competing processes of merger, blocking, and chain-shift.

2.2.3 [ɪ] and [ʏ], but not *[ʊ]

The deactivation of Marking Statement A3 in Modern Icelandic licenses [ɪ] and [ʊ], although the latter does not surface. For some reason, /ʊ/ is marked, and requires repair. This repair parallels the adjustment required for /æʲ/ in 2.2.2.4, where Negation of the feature [-back] resulted in the [+back] diphthong [aʲ].

In the case of /ʊ/, the segment undergoes Negation of its [+back] feature to become [-back], resulting in the extremely unusual front-rounded phoneme [ʏ]. Although in this case the repair process (Negation) seems straightforward enough, the cause of /ʊ/'s markedness is unclear.

Moreover, although Negation is a fundamental element of DP, in this case Negation actually *increases* markedness, because front-rounded vowels are universally more marked than back-rounded vowels. Yet not only is [ʏ] a phoneme in Icelandic, it is the language's epenthetic vowel - the default vowel - the equivalent of English schwa [ə]. Although DP is able to capture this data, the phonology of Icelandic vowels clearly requires further study.

2.2.4 Chapter summation

Modern Icelandic's vowel system can be captured with the marking statements, repairs, and rules listed in (2:10).

(2:10) DP specifications for the inventory of Modern Icelandic vowels

- Minimum complexity allows for .... **[i]**, **[u]**, **[a]**
    shortening/diphthongization of [aː] yields .... **[aʷ]**
    diphthongization (but not shortening) of [iː] and [uː] blocked by OCP

- [–low, <u>–high</u>] *deactivated*, allowing for [e] and [o]
  shortening/diphthongization of [eː] and [oː] yields .... **[ʲe], [oʷ]**
  diphthongization of [ej] yields .... **[eʲ]**

- [–high, <u>+ATR</u>] *deactivated*, allowing for .... **[ɛ], [ɔ]**

- [+high, <u>–ATR</u>] *deactivated*, allowing for [ʊ] and .... **[ɪ]**
  negation of the [+back] feature of [ʊ] yields .... **[ʏ]**

- [–back, <u>+round</u>] / __, –low] *deactivated*, allowing for [y], [ʏ], [ø] and .... **[œ]**
  shortening/diphthongization of [øː] yields .... **[øʲ]**

- [+low, <u>–back</u>] *active*: disallows [æː], [æ] and [æʲ]
  negation of the [–back] feature of [æʲ] yields .... **[aʲ]**

In this chapter I have applied Calabrese's model to two sets of data, showing that the theory is able successfully to handle a variety of phonological phenomena. These include the gap of short nasal vowels in Old Icelandic (with a possible refinement to the mechanism of compensatory lengthening), and the complex issue of diphthongization in Modern Icelandic.

I believe that I have established that DP is a workable model for Icelandic vowels, although in a few cases it functions only mechanically, without explanatory adequacy. Such are the characteristics of a work in progress.

In the next chapter I will apply DP to an interesting distribution problem involving the Modern Icelandic consonant system. I dispense with Old Icelandic from here on, because a comprehensive analysis of the inventory of Old Icelandic consonants would not only be uninteresting, it would sidetrack this dissertation from its main purpose, which is an investigation of glottal phenomena.

Chapter Three

The Icelandic Consonant System

3.1 Aspiration and voicing in a theoretical context

Swedish, Danish, Norwegian and Faroese – the other members of the North Germanic language family – all make a distinction between voiced and voiceless stops. Icelandic instead makes a distinction between aspirated and unaspirated stops, as demonstrated in (3:1).

(3:1) Pronunciation of *dal* (meaning 'valley') and *tal* (meaning 'speak' and/or 'amount') in the North Germanic languages

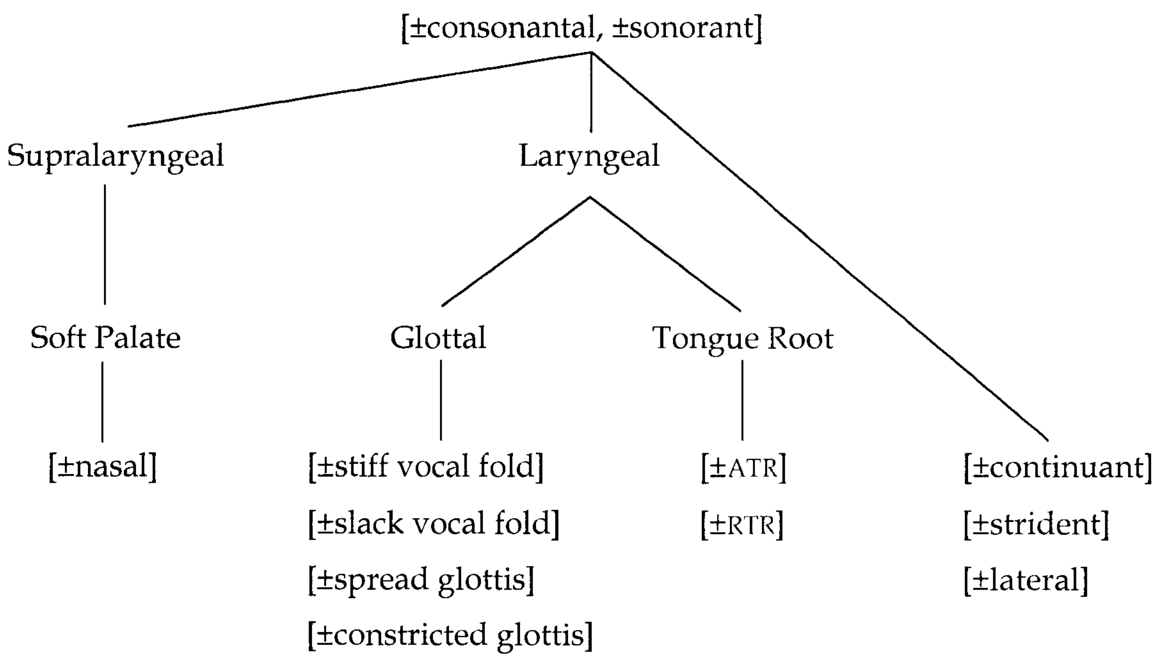
	dal	***tal***	
Swedish	[d]al	[tʰ]al	distinction: voicing
Danish	[d]al	[tʰ]al	distinction: voicing
Norwegian	[d]al	[tʰ]al	distinction: voicing
Faroese	[d]al	[tʰ]al	distinction: voicing
Icelandic	[t]al	[tʰ]al	distinction: aspiration

Except for the dialect of Swedish spoken in Finland, initial voiceless stops are always aspirated in Swedish, Danish, Norwegian and Faroese. Therefore, aspiration is not a distinctive feature of those languages.

There exists no voiced-voiceless contrast of obstruents in Icelandic. Instead, glottal constrast takes place in terms of aspiration – with its various and sometimes surprising reflexes. Both voicing and aspiration are usually considered to be glottal articulations, so in terms of distinctive features, I will assume here that aspiration is associated with [±spread glottis].

To create a context for the [+consonantal] segments of Icelandic, I present in (3:2) a Feature Geometry representation for consonants that is based on the Halle-Sagey Articulator Model (Halle 1992), taken from Kenstowicz 1994.

(3:2) A Model of Consonant Articulators



The nodes (Supralaryngeal , Laryngeal, Soft Palate, Glottal, and Tongue Root) refer to articulators or groupings of articulators. At the bottom of the hierarchy are the terminal features, which are shown here within square brackets beginning with a ± sign, such as [±spread glottis]. They are used to distinguish individual contrastive segments, and they are not universal. In Icelandic, the only terminal feature under the Glottal node is [±spread glottis], the feature that distinguishes aspirated stops from unaspirated stops (for example /pʰ/ ~ /p/), and also distinguishes voiced sonorants from voiceless sonorants (e.g. /n/ ~ /n̥/). Voiceless sonorants will be examined in detail later in this chapter, as well as in chapter four. Icelandic also makes use of two articulator-free terminal features: [±continuant] (/t/ vs /s/), and [±strident] (/θ/vs /s/).

3.2 Contrastive segments in Icelandic

A feature matrix of the Icelandic consonant system is shown in (3:3).

(3:3a) Contrastive segments of the Icelandic consonant system: obstruents

Orthography	b	p	d	t	g	k	f	s	þ/ð	h
Underlying Representation	/p/	/pʰ/	/t/	/tʰ/	/k/	/kʰ/	/f/	/s/	/θ/	/h/
[±consonantal]	+	+	+	+	+	+	+	+	+	+
[±sonorant]	–	–	–	–	–	–	–	–	–	–
[±nasal]	–	–	–	–	–	–	–	–	–	–
[±spread glottis]	–	+	–	+	–	+	–	–	–	+
[±continuant]	–	–	–	–	–	–	+	+	+	+
[±strident]	–	–	–	–	–	–	–	–	+	–
Labial	+	+					+			
Dental							+			
Coronal			+	+				+	+	
Dorsal					+	+				

(3:3b) Contrastive segments of the Icelandic consonant system: sonorants

Orthography	m	n	hn	ng	l	hl	r	hr	j	hj	v
Underlying Representation	/m/	/n/	/n̥/	/ŋ/	/l/	/l̥/	/r/	/r̥/	/j/	/j̊/	/w/
[±consonantal]	+	+	+	+	+	+	+	+	–	–	–
[±sonorant]	+	+	+	+	+	+	+	+	+	+	+
[±nasal]	+	+	+	+	–	–	–	–	–	–	–
[±spread glottis]	–	–	+	–	–	+	–	+	–	+	–
[±continuant]	–	–	–	–	–	–	+	+	+	+	+
[±strident]	–	–	–	–	–	–	–	–	–	–	–
Labial	+										+
Dental											
Coronal		+	+		+	+	+	+			
Dorsal				+					+	+	

3.3 Geminate consonants

The verb *mana* [mana] 'to dare' (i.e., apply bravado to make someone do something) contrasts with the verb *manna* [manːa] 'to man' (i.e., put together a crew for a fishing expedition). The alternation [mana] ~ [manːa] provides evidence that consonant length is contrastive in Icelandic. According to Kristinsson 1988, length is distinctive with respect to Icelandic obstruents and sonorants, but not the voiceless sonorants. (3:4) lists the Icelandic consonants that I contend are contrastive in terms of length.

(3:4) Icelandic consonants that are contrastive for length at the level of underlying representation

/p/ ~ /p:/	/pʰ/ ~ /pʰ:/	/f/ ~ /f:/
/t/ ~ /t:/	/tʰ/ ~ /tʰ:/	/s/ ~ /s:/
/k/ ~ /k:/	/kʰ/ ~ /kʰ:/	
/m/ ~ /m:/	/n/ ~ /n:/	
/l/ ~ /l:/	/r/ ~ /r:/	

3.3.1 Aspirated geminate stops

I will present evidence later in this dissertation to support /pʰ:/, /tʰ:/, and /kʰ:/ as underlying representations of aspirated geminate stops. The fact is, though, that /pʰ:/, /tʰ:/, and /kʰ:/ are never actually pronounced, and instead surface as the preaspirated stops [hp], [ht], and [hk]. Chapter four addresses this problem in great detail.

3.4 The role of syllable structure in nasals, liquids and glides

Many distinctive feature models (e.g. Kenstowicz 1994) partition the set /m, n, ŋ, l, r, j, w/ into three subsets, namely the nasals /m, n, ŋ/, the liquids /l, r/ and the glides /j, w/. Unexpectedly, there exists in Icelandic no phonological evidence to support a category that contains just the segments /l, r/. To my knowledge, there are no phonological processes that apply only to those two segments in Icelandic. On the contrary, several processes apply only to the set /m, n, l/ and not to the set /r, j, w/. One such process, obstruent gemination, is examined in detail in chapter four. There, I make the case that syllable structure plays a key role with respect to this problem, since only /r/, /j/, and /w/ can appear in an onset after a tautosyllabic obstruent, whereas in the same environment /m/, /n/, and /l/ must occur as coda consonants.

3.5 A DP analysis of the distribution of the voiceless sonorants

The distribution of the voiceless sonorants /n̥/, /l̥/, /r̥/, /j̊/ merits examination. On the one hand, minimal pairs provide what seems to be conclusive proof that the voiceless sonorants are phonemes, as shown in (3:5).

(3:5) Voiceless and voiced sonorants, minimal pairs

/n̥/	*hn*	*hné* ~ [n̥je] 'knee'	*né* [nje] 'nor'
/l̥/	*hl*	*hlíf* ~ [l̥if] 'shield'	*líf* [lif] 'life'
/r̥/	*hr*	*hrós* ~ [r̥os] 'praise'	*rós* [ros] 'rose'
/j̊/	*hj*	*hjá* ~ [j̊aw] 'with'	*já* [jaw] 'yes'

However, these segments only occur syllable-initially. While it is true that arbitrary gaps in the distribution of consonants do occur, in which case no linguistically-significant generalization is possible, these gaps often turn out to be valuable clues that point to phonological processes whose explanation provides insights into the nature of the language under examination. Such is the case with the voiceless sonorants; I suggest that their initial-only occurrences do not merely reflect arbitrary gaps in medial and final position. Instead, their distribution suggests the possibility that these segments result from some phonological process, perhaps of a historical nature. The observation that every orthographic occurrence of a voiceless sonorant is preceded by *h* (*hn* = /n̥/, *hl* = /l̥/, *hr* = /r̥/, *hj* = /j̊/) serves as a possible clue to the distribution question.

Before embarking on a DP analysis of the situation, it will be important to mention a pertinent contribution of phonological theory, the Sonority Sequencing Principle (SSP, Selkirk 1982). The SSP is a constraint which holds that syllable-initial members of a consonant cluster must increase in relative sonority from left to right, while in final position (after the vowel), consonant cluster constituents must decrease in sonority from left to right. The sonority hierarchies proposed in Kenstowicz (1994) and Roca & Johnson (1999) both agree that obstruents are less sonorant than nasals, liquids and glides. According to the chart in (3:2), [h] is an obstruent and thus less sonorant than [n], [l], [r] and [j], so the combinations *hn*, *hl*, *hr* and *hj* would satisfy the SSP in initial position but violate the SSP in final position.

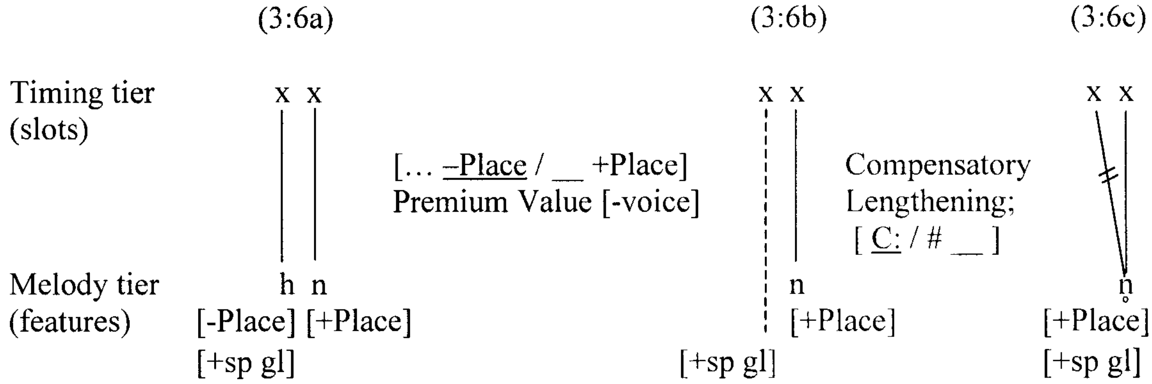
Of course, all this suggests that the voiceless sonorants were at one point in time composed of a sequence of [h] followed by the corresponding voiced sonorant. It must also be taken into account that, according to all theories of markedness, voiceless sonorants are marked relative to their voiced counterparts.

What set of DP premium value assignments and/or marking statements (and which associated repairs) can be proposed that would make, for example, the sequence [hn] *more* marked than the voiceless sonorant [n̥]? Under DP it is possible to attribute premium value to [+spread glottis].

I suggest that a premium value is assigned to [+spread glottis], given that there are no voiced obstruents in the consonant inventory. I also contend that the marking statement against [+spread glottis] sonorants, [+sonorant, <u>+spread glottis</u>], is deactivated in Icelandic (since voiceless sonorants do occur), while the marking statement against initial geminates [<u>C:</u> / # __] is active in the language (since initial geminates do not occur).

Given the status of those three marking statements and the premium value assignment, the process would take the shape represented in (3:6) below.

(3:6) Development of an [h] + sonorant sequence into a voiceless sonorant



The sequence [hn] (3:6a) violates [+consonantal, -Place / __ +Place], so a repair is invoked. That repair entails the deletion of the marked (-Place) segment [h], although its feature [+spread glottis] remains, since [+spread glottis] enjoys a premium value assignment (3:6b). Next, compensatory lengthening (discussed in chapter 2) results in the assimilation by [n] of [h]'s timing slot, including the remaining [+spread glottis] feature (3:6c). This move leads to a violation of the constraint against initial geminates, however, so the ensuing repair disconnects the link between [n] and [h]'s old timing slot (represented by the double slash through the association line in (3:6c). The outcome is the singleton voiceless sonorant [n̥].

To sum up, the distribution of the voiceless sonorants can be attributed to a premium value assignment for [+spread glottis], plus the following marking statements:

- [-Place / __ +Place]: [h] cannot be followed by a consonant...*active*
- [+sonorant, +spread glottis]: no voiceless sonorants...*deactivated*
- [C: / # __]: no initial geminates...*active*

Chapter Four

Glottal Effects

4.1 Introduction

This chapter examines aspiration, preaspiration, sonorant devoicing, deaspiration, and obstruent gemination. These phenomena have long been thought to be interrelated in Icelandic, but no proposal has successfully captured the underlying relationship that obtains among them - until now.

After laying out the facts of the matter, I present an important preliminary analysis from the 1970s, followed by four other attempts to relate some of these phenomena in a single model. Although those attempts fall short or fail altogether, I show how the results of that research - plus my new work on obstruent gemination - impact the two prevailing theories of consonant length. Finally, I apply Calabrese's model of rules and constraints to relate and explain all of the phenomena mentioned above.

The following four paragraphs provide a broad overview of what these phenomena are, under what circumstances they occur, and why they are interesting; more detailed discussions on these topics will be presented later on in the chapter.

Aspiration is represented in phonology by [+spread glottis]. In Icelandic, aspiration is contrastive, so in the northern dialect (considered more 'formal' or more 'correct') the feature [+spread glottis] can surface with any stop that is underlyingly [+spread glottis], whether initial, medial or final. In the southern dialect, aspiration only surfaces in stressed syllables, which are always initial.

The consonant sequences [hp], [ht] and [hk] are called preaspirated stops, and the process that gives rise to those sequences is known as **preaspiration**. The preaspirated stops are always derived, and they only occur under two circumstances: when an underlying stop is both aspirated and long (for example /pʰː/ → [hp]), and when a short aspirated stop is followed by /l/ or /n/ (e.g. /pʰn/ → [hpn]). The questions here are, why would just those two circumstances cause preaspiration? What do they (long aspirated stop, and short aspirated stop + /l/ or /n/) have in common? Another fact of interest here is that, under both circumstances, the stop surfaces without aspiration.

Since there are no voiced obstruents in Icelandic, **devoicing** (a process that involves a change in feature value from [-spread glottis] to [+spread glottis]) only affects the sonorants /m/, /n/, /l/ and /r/, yielding their voiceless versions [m̥], [n̥], [l̥], and [r̥]. Devoicing occurs when a sonorant precedes one of the aspirated stops /pʰ/, /tʰ/ or /kʰ/. So, for example, underlying /mpʰ/ surfaces as [m̥p]. Notice that the [p] has lost its aspiration in this example, suggesting that the devoicing feature [+spread glottis] has shifted to the left, from the stop to the sonorant. Deaspiration of the stop happens consistently whenever devoicing occurs.

Deaspiration is the term used when the underlying aspirated stops /pʰ/, /tʰ/ and /kʰ/ surface as [p], [t] and [k], i.e. without aspiration. As mentioned above, deaspiration occurs in the southern dialect when underlying aspirated stops are not word-initial (thus not stressed). Much more interesting for the present analysis, however, is the observation that deaspiration occurs whenever preaspiration occurs, and also whenever sonorant devoicing occurs.

These phenomena form the core data set that will be scrutinized in this chapter, which is structured as follows:

Section 4.2 presents distributional facts about Icelandic aspiration-related phenomena: §4.2.1 examines aspiration and preaspiration, §4.2.2 addresses aspiration and vowel length, §4.2.3 focuses on preaspiration in consonant clusters, and §4.2.4 covers devoicing.

Section 4.3 uses alternation data to provide more details about Icelandic: §4.3.1 illustrates that preaspiration is not an underlying phenomenon, §4.3.2 shows that devoicing fails to occur across compound boundaries, and §4.3.3 demonstrates that while compound boundaries obscure the underlying vs. derived status of surface forms, they provide an intriguing insight into the nature of preaspiration.

Section 4.4 examines four attempts to model preaspiration and its associated phenomena. §4.4.1 considers the two-root theory of length in Selkirk (1990), §4.4.2 examines Jónsson's (1994) vowel delinking model, §4.4.3 presents Keer's (1998) segmental aspiration approach under the moraic theory of geminates, and §4.4.4 describes Ringen's (1999) paper where aspiration - more specifically, the feature [spread glottis] - must be shared with two segments in order to surface. §4.4.5 is a summary and analysis of the four models of preaspiration, two of which are shown to be inadequate.

Section 4.5 addresses obstruent gemination and its impact on the modelling of preaspiration. §4.5.1 is an introduction to obstruent gemination, §4.5.2 examines velar spirantization as phonological evidence for obstruent gemination, §4.5.3 presents two sets of phonetic evidence for obstruent gemination, and §4.5.4 shows how obstruent gemination is impossible to account for in one of the two remaining models examined in section 4.4.

Section 4.6 addresses how the findings developed in section 4.5 affect the competition between the two most popular current theories of length.

Chapter five lays out my new analysis, which brings together all the aspiration-related phenomena mentioned so far in chapter four. §5.1 recaps the basics of Calabrese's (1995) model of markedness and repair, §5.2 addresses preaspiration derived from a geminate aspirate, §5.3 addresses sonorant devoicing, and §5.4

shows how aspiration does surface in a singleton stop when preceded by a vowel segment.

4.2 Distributional facts

4.2.1 Aspiration and preaspiration

As mentioned in chapter 3, Icelandic is contrastive for aspiration, not voice, and stops are contrastive for length as well as aspiration. These contrasts can be seen in *bagi* 'inconvenience' vs *baggi* 'bundle', where length is contrastive, and in *bagi* 'inconvenience' vs *baki* '(horse)back', where aspiration is contrastive. The relationships between *bagi, baggi,* and *baki* are shown in (4:1).

(4:1) Contrastiveness of consonant length and aspiration

	SINGLETON			GEMINATE		
UNASPIRATED	*bagi*	/pakɪ/	[paːɣɪ]	*baggi*	/pakːɪ/	[pakːɪ]
ASPIRATED	*baki*	/pakʰɪ/	[paːkɪ]	*bakki*	/pakʰːɪ/	*[pakʰːɪ]

The geminate aspirated form in (4:1), *[pakʰːɪ], is starred to indicate that geminate aspirated stops do not surface in Icelandic. Instead, the underlying aspirated geminate stop /kʰː/ undergoes preaspiration, and surfaces as [hk]. So, *bakki* /pakʰːɪ/ 'riverbank' is pronounced [pahkɪ]. The above distributional evidence, plus the arguments put forth in the Preaspiration section (§4.3.1 below), indicate that preaspiration is the result of a derivational process, rather than an underlying phenomenon.

4.2.2 Aspiration, vowel length and the bisegmentality of preaspirated stops

In Icelandic, stress falls on the first syllable of every word. Moreover, vowels are long if and only if they are stressed in open syllables (i.e. in initial open syllables). Vowel length is, therefore, phonetic.

(4:2) Vowel length in stressed (initial) syllables

	LONG VOWELS	SHORT VOWELS
(4:2a) FINAL C UNASPIRATED	*lag* /lak/ [laːk] 'sheet'	
(4:2b) FINAL C ASPIRATED	*lak* /lakʰ/ [laːkʰ] 'tune'	
(4:2c) FINAL C CLUSTER		*tank* /tank/ [taŋk]
(4:2d) FINAL GEMINATE C		*egg* /ɛkː/ [ɛkː]
(4:2e) FINAL PREASPIRATED C		*takk* /takʰː/ [tahk]

As mentioned in chapter three, a single word-final consonant following an initial vowel does not keep the vowel from lengthening, as shown in (4:2a) and (4:2b). This means that the consonant does not serve as a coda for the syllable; in this situation I analyzed the final consonant as extrametrical, or in any event extrasyllabic. Only one such extrasyllabic consonant ever occurs.

A consonant cluster does close the syllable and inhibit vowel lengthening in (4:2c), as does a final (unaspirated) geminate (4:2d), as well as an underlyingly-aspirated geminate with surface preaspiration (4:2e). Only one extrasyllablic consonant ever occurs.

The preaspirated output (4:2e) follows a short vowel for the same reason that the consonant cluster in *tank* (4:2c) does: both sequences are made up of two segments, the first of which closes the syllable. I conclude from this data that a preaspirated stop consists of two segments, the first of which is [h], the second being [p], [t] or [k]. This bisegmental analysis of preaspiration was first put forward on a phonetic level by Garnes (1976), and on a phonological level by Thráinsson (1978). Nevertheless, not everyone agrees that the [h] of preaspiration is in fact a segment; other views are presented in section 4.4, Proposed Models.

4.2.3 Preaspiration in consonant clusters

In all dialects, preaspiration occurs with /p^h, t^h, k^h/ + /l, m, n/ as in (4:3). Note that the initial vowels of (4:3) are short. This shortness will become significant later on in the chapter, as well as in chapter five.

(4:3) Preaspiration preceding /l, m, n/

pl	*epli*	[ɛhplɪ]	'apple'	pn	*opna*	[ɔhpna]	'open'
tl	*ætla*	[a^{j}htla]	'broaden'	tn	*vatn*	[vahtn]	'water'
kl	*miklir*	[mɪhklɪr]	'great'	kn	*sakna*	[sahkna]	'miss'

Cluster preaspiration has also been shown to occur with /m/ in the borrowed word *ritma* [rɪhtma] 'rhythm'.

It is interesting to observe that, if the [h] of preaspiration is indeed an independent segment, then all the examples in (4:3) reflect the generation of three output segments from an underlying sequence of just two segments. I elaborate on this observation in section 4.5, Obstruent Gemination and Preaspiration, below.

Also, note that the syllable-initial vowels of (4:3) are all short; this fact will become significant later on in the dissertation.

4.2.4 Devoicing in consonant clusters

In most dialects of Icelandic, all sonorants preceding /p^{h}/, /t^{h}/ and /k^{h}/ are devoiced. Table (4:4) shows a devoiced sonorant followed by a deaspirated stop, then the same word in the *raddaður framburður* dialect, which shows neither devoicing nor deaspiration.

(4:4) Sonorant devoicing accompanied by deaspiration of a stop

SOUTHERN DIALECT	*vanta*	/vant^{h}a/	[van̥ta]	'need'
RADDAÐUR FRAMBURÐUR	*vanta*	/vant^{h}a/	[vant^{h}a]	'need'

The *raddaður framburður* dialect, spoken in parts of northern Iceland, suggests that devoicing and deaspiration are linked. When southern-dialect deaspiration occurs, devoicing also occurs. But in the absence of devoicing, underlying aspiration surfaces. So, both phenomena occur together, or neither occur.

4.3 Alternations

4.3.1 Preaspiration

In section 4.2.1, I asserted that preaspirated stops should be seen as the surface representations of underlying aspirated geminates. Evidence supporting the thesis that preaspiration is not underlying can be found in many instances of Icelandic alternation; the following two examples adapted from Thráinsson (1978) should suffice to establish that preaspiration results from a derivational process.

(4:5) Adjective alternations

		FEMININE SINGULAR			NEUTER SINGULAR		
(4:5a)	'rich'	*rík*	/rikʰ/	[riːkʰ]	*ríkt*	/rikʰ + tʰ/	[rixt]
(4:5b)	'sweet'	*sæt*	/saʲtʰ/	[saʲːtʰ]	*sætt*	/saʲtʰ + tʰ/	[saʲht]

Table (4:5) shows two adjectives in the feminine singular - the root form - and the same adjectives with the neuter singular ending /tʰ/. In (4:5a), affixing the /tʰ/ results in a consonant cluster, which prevents the vowel from lengthening. The /tʰ/ affixation in (4:5b) also prevents the vowel from lengthening; moreover, it results in preaspirated [ht].

The surface forms of (4:5b) are simple to explain if the concatenation of the root /tʰ/ with a /tʰ/ suffix forms an aspirated geminate that undergoes a preaspiration process, yielding [ht]. If the preaspirated form were underlying in the neuter singular ending, the [h] would have to be suppressed from the output of (4:5a), as well as for all stems ending in anything other than /t^h/, a much less desirable analysis.

(4:6) Adjective alternations with assimilation; from Thráinsson 1978

	FEMININE SINGULAR			NEUTER SINGULAR		
'bored'	*leið*	/$le^j\theta$/	[le^jːð]	*leitt*	/$le^j\theta + t^h$/	[le^jht]

Table (4:6) shows an adjective of the same class as those in (4:5), namely with the underlying stem represented by the feminine singular form (in this case /$le^j\theta$/), and a neuter singular ending of /t^h/. The preaspirated output of the neuter singular form is best explained as a combination of concatenating the stem and the ending (/$le^j\theta + t^h$/), assimilation of the final obstruents (/$le^jt^h + t^h$/), and preaspiration, all of which result in the surface form [le^jht]. It is notable that this explanation requires the ordered application of rules.

Rejecting the preaspiration explanation in this case would require the existence of an independent process that changes underlying /θ/ to [h]. Anticipating the stop-gemination discussion of section 4.5, it should be noted that the obstruent concatenation seen here (/$\theta + t^h$/) does not result in an increase in the total number of segments.

4.3.2 Devoicing at Compound Boundaries

We have seen in §4.2.4 that sonorants devoice when followed by the aspirated stops /p^{h}/, /t^{h}/, /k^{h}/ except in the *raddaður framburður* dialect. Devoicing also fails to occur across compound boundaries in all dialects. See tables (4:7), (4:8) and (4:9) for examples.

(4:7) Tautomorphemic sonorant + aspirated-stop environments, southern dialect

(4:7a)	*malta*	/malt^{h}a/	[mal̥ta]	'malt'
(4:7b)	*samt*	/samt^{h}/	[sam̥t]	'still, yet'

(4:8) Tautomorphemic sonorant + aspirated-stop environments, *raddaður framburður*

(4:8a)	*malta*	/malt^{h}a/	[malt^{h}a]	'malt'
(4:8b)	*samt*	/samt^{h}/	[samt^{h}]	'still, yet'

(4:9) Cross-compound sonorant + aspirated-stop environments, all dialects

(4:9a)	*máltaka*	/ma^{w}l + t^{h}aka/	[ma^{w}lt^{h}aka]	'language acquisition'
(4:9b)	*samtals*	/sam + t^{h}als/	[samt^{h}als]	'all told, altogether'

These combinations also show no increase in the number of segments.

4.3.3 Preaspiration at compound boundaries

This chapter has shown that preaspiration arises from the underlying geminate aspirated stops /p^{h}:/, /t^{h}:/, /k^{h}:/, and that preaspiration does occur across morpheme boundaries, as seen in the neuter singular form of (4:5b). However, the structural description of preaspiration does not cross compound boundaries, as demonstrated in (4:10) and (4:11).

(4:10) Tautomorphemic /t^{h}l/ and /k^{h}ː/ environments

(4:10a)	*fatlaður*	/fat^{h}laðʏr/	[fahtlaðʏr]	'handicapped'
(4:10b)	*ekki*	/ɛk^{h}ːɪ/	[ɛhkɪ]	'not'

(4:11) Cross-compound /t^{h}l/ and /k^{h}ː/ environments
(# = compound boundary)

(4:11a)	*útlendingur*	/ut^{h}#lɛntɪnkʏr/	[uːtlɛntɪŋkʏr]	'foreigner'
(4:11b)	*reykkafari*	/re^{j}k^{h}#k^{h}afarɪ/	[rɛ^{j}ːk^{h}aʋarɪ]	'smoke diver'

Although alternations across morpheme boundaries can be useful in determining whether a segment is underlying or derived, compound boundaries block processes such as deaspiration, preaspiration, and vowel lengthening. Thus, environments including compound boundaries cannot alone provide insights into the underlying or derived status of observed alternations.

Nevertheless, compound boundaries do provide insight into the nature of preaspiration. In (4:11b), because the structural description normally resulting in preaspiration would cross a compound boundary, the sequence /…k^{h}#k^{h}…/ does not surface as [hk]. Neither does it surface as […k^{h}k^{h}…] (the long aspirated stop, identical to the input – and symbolized everywhere else in this chapter as

/k^h:/). Instead one of the obstruents drops out, and what surfaces is the singleton aspirated stop [k^h].

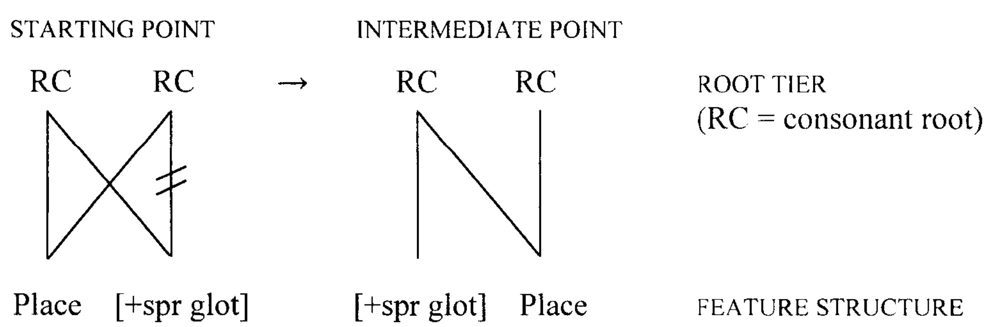
Evidently, both the geminate aspirate and a sequence of two identical obstruents are unpronounceable. Icelandic resolves the problem of geminate aspirates with preaspiration, which maintains the underlying distinction between words with long versus short aspirated stops. If preaspiration proves impossible, as in the case of a sequence of identical aspirated obstruents, the grammar will delete one of the the stops, even though any underlying consonant length distinction is thereby lost.

4.4 Proposed models

4.4.1 Selkirk 1990: a two-root theory of geminates

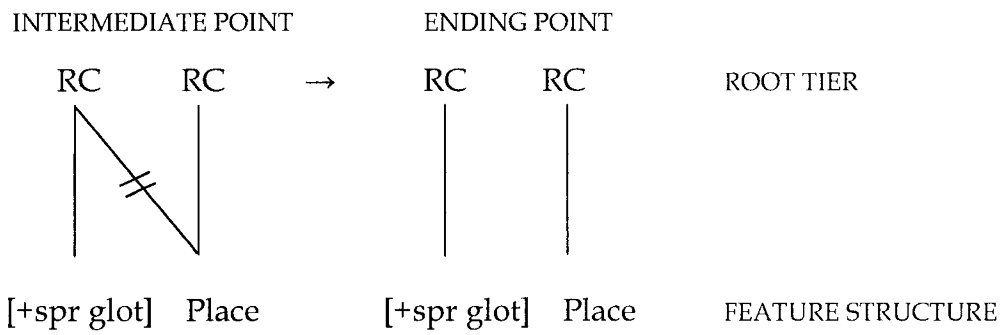
In *A two-root theory of length*, Selkirk (1990) explains preaspiration as a two-step process beginning with the transfer of [+spread glottis] from the final root to the initial root of a two-root geminate, as seen in (4:12).

(4:12) /pp^h/ → /p^hp/



The process concludes by delinking the place features, as shown in (4:13), resulting in the aspiration followed by the stop.

(4:13) /p^hp/ → [hp]



If the result of these processes is a single segment, however many roots are involved, then we would expect any vowel in a word-initial syllable preceding such a segment to be long. This is because word-initial syllables are stressed, and vowels in stressed open syllables are long. Also, only geminates or bisegmental codas can close a syllable in Icelandic. Under Selkirk's model, if [hp] is a single segment (albeit a two-root segment), it would fail to close its syllable and therefore leave the vowel long. However, as we have seen, and as we can see again in (4:14), vowels in a word-initial syllable that precede a preaspirated stop are short.

(4:14) Preaspirated stops close the syllable

sætt	/$sa^jt^h + t^h$/	[sa^jht]	'sweet + neuter singular'
takk	/tak^hk^h/	[tahk]	'thanks'

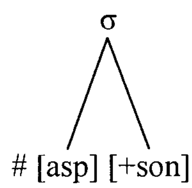
Therefore, Selkirk's two roots must correspond to a *bisegmental* output in order to adequately explain the consequences of her preaspiration model. Although she does not address in her paper the issue of surface segmental quantity, there appears to be no reason why the two-root model should not yield a bisegmental output, and if it does, the model captures preaspiration successfully.

4.4.2 Jónsson (1994): vowel delinking

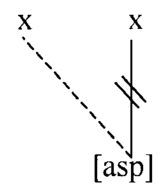
The feature [asp] in Icelandic phonology, Jónsson's 1994 model, calls for aspiration to be licensed in surface representation. The condition for licensing, expressed in (4:15), below, is a word-initial environment, restricting aspiration to word-initial segments. Stops that are underlyingly aspirated, but whose aspiration is not licensed by (4:15), undergo an automatic process of aspiration delinking. This occurs with all medial and final aspirated stops. A relinking rule, formulated in (4:16), then attaches the delinked feature [asp] to the immediately-preceding segment.

For Jónsson's approach to work, Icelandic vowels in stressed syllables must be underlyingly long. That is, the initial vowel must contain a preexisting second segment which receives the delinked [asp] feature after having lost its association to the vowel. This loss of association to the vowel occurs when underlyingly-long vowels shorten in a closed syllable, a process represented by the rule in (4:17).

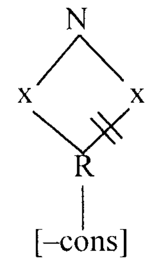
(4:15) *Licensing condition for [asp]*



(4:16) *Relinking rule*



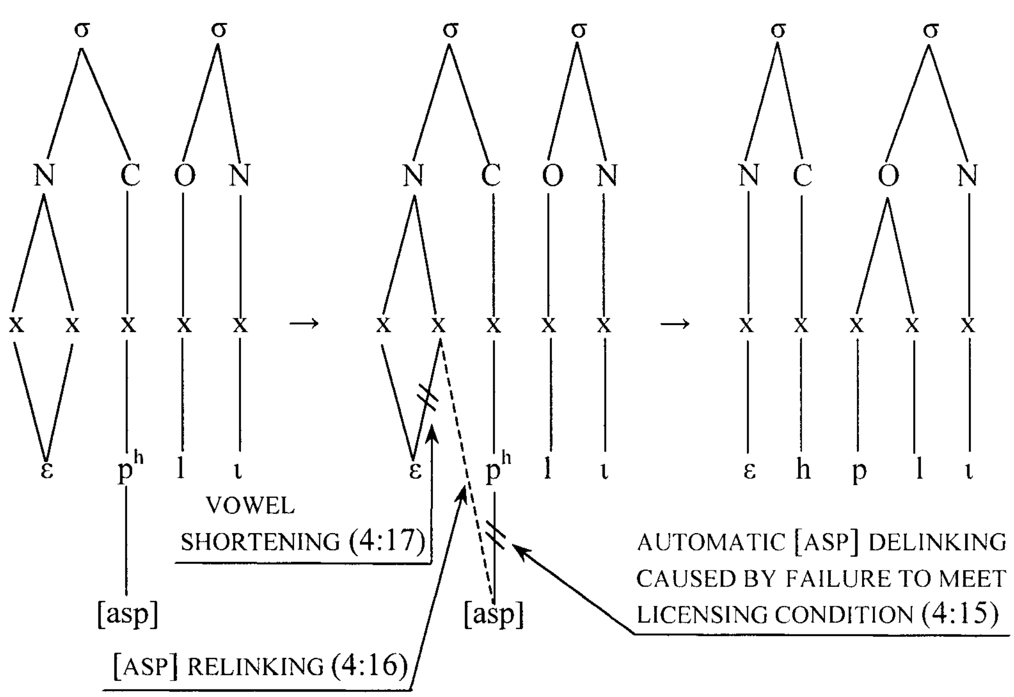
(4:17) *Vowel shortening*



(N = nucleus; R = root node)

This entire process is demonstrated in (4:18) with *epli* [ɛhplɪ] 'apple': the initial vowel is shortened, leaving an unattached segment; the aspiration feature is delinked from its [p] segment; and the aspiration feature is relinked to the adjacent segment on the left, which was previously part of the vowel /ɛ/.

(4:18) Preaspiration in Jónsson 1994: *epli* [ɛhplɪ] 'apple'



Jónsson's requirement that "vowels in stressed syllables are long in underlying representation" would entail that long and short vowels should be contrastive in some cases. However, there are no minimal pairs contrasting long and short vowels in Icelandic. Moreover, long vowels occur only and always in initial open syllables.

The absence of minimal pairs between long and short vowels and their complementary distribution do not necessarily preclude underlying vowel length. However, every argument (including Keer's, below) that I have seen for underlying vowel length goes like this: the current analysis requires underlying vowel length, the current analysis is valid, so underlying vowel length is valid. No one has provided evidence for underlying vowel length that is independent of the analysis being proposed.

The lack of model-independent (i.e. non-circular) evidence, the lack of minimal pairs, and the complementary distribution of long and short vowels together make the concept of underlying long vowels highly questionable. Under these circumstances, any model that is crucially dependent on underlying vowel length, such as Jónsson's, should be viewed with suspicion.

The second problem centers on how the model could determine at the level of UR whether or not a certain vowel will surface in initial-syllable position. The model requires such an ability, since it establishes a distinction between stressed syllables and unstressed syllables in underlying representation. To make the distinction, it is necessary to determine at the level of UR whether a given vowel will surface in a word-initial syllable, since only word-initial syllables are stressed. Such a determination seems impossible, since later morphological processes can add a prefix that shifts stress to the left. Even if the model could be aware that prefixation was in the offing, it would also have to know which specific prefixes were involved, since some affect stress while others, notably *ó-* (corresponding to English un-), do not.

4.4.3 Keer 1998: segmental aspiration

Keer's 1998 paper, *Icelandic preaspiration and the moraic theory of geminates*, begins by assuming that aspiration itself is segmental. This contrasts with the prevailing view that aspiration is a feature of a segment, rather than a segment in its own right. So, under Keer's model, a regular (post)aspirated stop consists of two segments: the stop segment followed by the aspiration segment. Preaspiration then results from a process of metathesis ([ph] → [hp]). This takes place when an underlyingly long vowel is shortened before a consonant cluster that is unable to split into a coda followed by an onset.

In Keer's Optimality-theoretic model, constraints against long vowels and stop-aspiration sequences, plus an array of better-known constraints such as a sonority sequencing requirement, a ban on codas, and several faithfulness statements, allow the author to capture initial aspiration, preaspiration, and deaspiration.

Although the model produces good results from a mechanical perspective, i.e. the constraints appropriately ranked in a tableau *do* yield aspiration, preaspiration and deaspiration, two of the proposal's underlying assumptions are, in my opinion, fatally flawed. Evidence for the two problematic assumptions is provided in (4:19), (4:20) , (4:21), and (4:22).

The constraints for (4:19) and (4:20) are as follows: *[hO constrains against preaspirated onsets, WT-IDV constrains against lengthening or shortening vowels, *STOP-H constrains against a stop followed by an aspirated segment, and LIN constrains against metathesis.

(4:19) *tala* [t^ha:la] 'speak' with underlying vowel length

/thaala/	*[hO	WT-IDV	*STOP-H	LIN
☞ thaala	–	–	×	–
htaala	× !	–	–	×
thala	–	× !	×	–

(4:20) *tala* [tʰa:la] 'speak' without underlying vowel length

/thala/	*[hO	WT-IDV	*STOP-H	LIN
💣 thaala	–	× !	×	–
htaala	× !	–	–	×
☞ thala	–	–	×	–

The first problem is Keer's requirement that some vowels must be underlyingly long. I demonstrate this requirement in (4:19) and (4:20). The tableau in (4:19), with its long underlying vowel, yields the correct output [tʰa:la], with a long [a:].

Conversely, the tableau in (4:20), with its short underlying vowel, yields the incorrect output [tʰala], with a short [a]. (The bomb symbol, 💣, represents the target output, while the incorrect winner is indicated by the pointing finger symbol ☞.)

Thus, Keer's model requires underlying long vowels. I addressed the severe problems associated with positing underlying vowel length in the preceding analysis of Jónsson (1994).

(4:21) *epli* [ɛhplɪ] 'apple' with bisegmental (post)aspiration

/eephli/	SONSEQ	WT-IDV(HD)	*STOP-H	WT-IDC(HD)	LIN
ee.phli	×× !	–	×	–	–
ep.hli	×	×	× !	×	–
☞ eh.pli	×	×	–	×	×

(4:22) *epli* [ɛhplɪ] 'apple' with monosegmental (post)aspiration

/eep^{h}li/	SONSEQ	WT-IDV(HD)	*STOP-H	WT-IDC(HD)	LIN
ee.phli	×× !	–	×	–	–
☞ ep^h.li	×	×	–	×	–
ep.hli	×	×	× !	×	–
💣 eh.pli	×	×	–	×	× !

The constraints for (4:21) and (4:22) are as follows: SONSEQ requires that onset clusters must rise in sonority, WT-IDV(HD) constrains against lengthening or shortening vowels in stressed syllables, *STOP-H constrains against a stop followed by an aspirated segment, WT-IDC(HD) constrains against lengthening or shortening consonants in stressed syllables, and LIN constrains against metathesis.

Another problem with Keer (1998) is that aspirated stops must be bisegmental. I demonstrate this necessity in (4:21) and (4:22). The tableau in (4:21), with its bisegmental aspirated stop, yields the correct output [ɛhplɪ], with preaspiration. Conversely, the tableau in (4:22), with its monosegmental aspirated stop, yields the incorrect output [ɛp^{h}lɪ], without preaspiration. Thus, Keer's model requires that preaspirated stops be bisegmental.

The bisegmentality of aspirated stops cannot be universally true. Many languages, including Chinese and Korean, have a phonotactic constraint against complex onsets (e.g. *[stài], *[trài]), and hence would prohibit aspirated stops in word-initial position if they were bisegmental. Of course, Mandarin Chinese *does* permit aspirated stops initially, as in [t^{h}ài] 'too much' vs [tài] 'put on'. So, either aspiration is not bisegmental, and the basic premise of Keer's model is nullified, or bisegmental aspiration is a property specific to languages like Icelandic, which seems unlikely, and in any event is not suggested as a possibility by Keer.

To conclude this section: Keer's 1998 model fails because of its unavoidable stipulations that vowel length is underlying in Icelandic, and that aspiration is bisegmental. No evidence is provided for either stipulation, whereas a preponderance of evidence is available to refute both.

4.4.4. Ringen (1999): MULTLINK

Another attempt at explaining preaspiration under the one-root theory of geminates is Ringen (1999), which stipulates that stops are unaspirated for one of two reasons: they have no [spread glottis] feature, or they *share* [spread glottis] with another consonant (in which case neither consonant is aspirated). Conversely, a stop that has the feature [spread glottis], and does *not* share that feature with another consonant (a marked situation), will surface as an aspirated stop.

Ringen considers that her model is "consistent with the assumption that geminates are moraic consonants," which refers to the one-root theory of geminates. That quote, of course, leaves open the possibility for some other model of consonant length, although the one-root model and the two-root model – the only ones currently in contention – are mutually incompatible.

Ringen (1999) is an OT analysis. Although the tableaux do mechanically output preaspiration and sonorant devoicing, the model proposes some concepts that seem questionable. Why, for example, should [spread glottis] be the one and only feature in the language whose salient characteristic is a failure to surface? Some of her markedness constraints also give pause. For instance, the markedness of voiceless [n̥], [m̥] and [l̥] is claimed to be different than the markedness of voiceless [r̥], which requires its own separate constraint. Why?

While these questions may appear to weaken Ringen (1999), they do not by themselves rule it out. It turns out that an in-depth critical analyis of the model is impossible outside the context of obstruent gemination. Therefore, a complete investigation of Ringen (1999) will be postponed until section 4.5, which includes a comprehensive exploration of the obstruent gemination phenomenon.

4.4.5 Summary and analysis

In Selkirk (1990)'s two-root analysis, [spread glottis] and the Place node metathesize with respect to their corresponding nodes on the root tier. This takes place in a two-step process that involves delinking and relinking. The model is successful, as long as the two roots correspond to a bisegmental output.

In Jónsson (1994), an aspirated stop can surface only initially. Non-initial stops that are underlyingly aspirated will delink [asp] and relink it to the next segment on the left. This model has two flaws: it posits underlying vowel length, which is undesirable and otherwise unnecessary, and it requires information-sharing between the lexicon and morphosyntax.

Keer (1998) posits that aspiration is itself a segment, and preaspiration results from metathesis of the stop segment and the aspiration segment. Like Jónsson (1994), this model is weakened by requiring underlying vowel length. It is further flawed by its stipulation that aspiration is a segment.

In Ringen (1999) the feature [spread glottis] is normally shared between adjacent segments. Aspiration only surfaces when [spread glottis] occurs but there is no sharing, a marked situation. Although it raises several questions, the model successfully captures preaspiration and several related phenomena. It will be further examined in section 4.5.

To sum up, Jónsson (1994) and Keer (1998) do not achieve their goals for a variety of reasons. That leaves two analyses remaining as potentially successful models of preaspiration in Icelandic: Selkirk (1990), which uses a two-root model of length, and Ringen (1999), which is consistent with a moraic (one-root) theory of geminates.

4.5 Obstruent gemination and preaspiration

4.5.1 Obstruent gemination and its theoretical consequences

Obstruent gemination is a process that was first posited in the 1970s, notably by Garnes (1974) and Thráinsson (1978), but it has largely been ignored since then. The idea is that the unaspirated stops /p/, /t/ and /k/ – as well as their aspirated counterparts /pʰ/, /tʰ/ and /kʰ/ – will become geminates whenever they precede /l/, /m/ or /n/, i.e. whenever they occur in in syllable-final position. So, if obstruent gemination *does* occur, the surface length of the underlyingly-long /tː/ in the word *edda* /ɛtːa/ 'an Icelandic poem' should match the surface length of the underlyingly-short /t/ in *Edna* /ɛtna/ 'a woman's name'.

Do stops in fact lengthen before /l/, /m/ and /n/? If they do not, then Ringen's (1999) multi-link analysis (§4.4.4) scores two achievements, first as the only successful model of preaspiration based on the one-root theory of length, and second as the only successful OT model of preaspiration and related phenomena. If obstruent gemination *were* to take place, then Ringen (1999) would be incompatible with the data (as will be demonstrated in §4.5.4 below), although on the positive side, the structural description for preaspiration would be greatly simplified.

As mentioned above (§4.1) and repeated here, preaspiration occurs when an underlying stop is both aspirated and long (e.g. /pʰː/ → [hp]), or when a short aspirated stop is followed by /l/, /m/ or /n/ (e.g. /pʰn/ → [hpn]). What, it was asked in the introduction to this chapter, do "long aspirated stop" and "short aspirated stop followed by /l/, /m/ or /n/" have in common? The answer, I propose, is nothing more than the aspirated stop. When followed by /l/, /m/ or /n/, the aspirated stop undergoes gemination, resulting in a stop that is both aspirated and long – which is the one and only intermediate representation that will surface as a preaspirated stop.

This proposal is desirable, but it requires the obstruent gemination process, which cannot coexist with the analysis in Ringen (1999). It thus becomes necessary to seek independent evidence, preferably both phonological and phonetic, of obstruent gemination in Icelandic. The following two sections provide such evidence.

4.5.2 Velar spirantization as phonological evidence for obstruent gemination

In Icelandic, orthographic *g* surfaces as a singleton unaspirated [k] when word-initial, as shown in (4:23a); elsewhere it spirantizes to [ɣ], as shown in (4:23b).

(4:23) Singleton velar stops, initial vs non-initial. Kristinsson (1988), Hólmarsson (1989)

(4:23a) SINGLETON INITIAL	(4:23b) SINGLETON NON-INITIAL
gas /kas/ [ka:s] 'gas'	*saga* /saka/ [sa:ɣa] 'story'

By contrast, orthographic 'gg' does not spirantize; it always surfaces as a geminate unaspirated [k:], as shown in (4:24):

(4:24) Geminate (non-initial) velar stop

Siggi /sɪk:ɪ/ [sɪk:ɪ] 'nickname for Sigmund'

A singleton non-initial velar stop followed by /r/ spirantizes, as might be expected (4:25a). However, a singleton non-initial velar stop followed by /l/ does *not* spirantize, as shown in (4:25b).

(4:25) Singleton velar stops followed by /-r/ and /-l/

(4:25a) SINGLETON NON-INITIAL + /r/	(4:25b) SINGLETON NON-INITIAL + /l/
sigra /sɪkra/ [sɪ:ɣra] 'defeat'	*sigla* /sɪkla/ [sɪk:la] 'sail'

Instead, the stop in (4:25b) behaves like the stop in (4:24), which is a geminate. Significantly, /l/ belongs to the set of sounds that trigger preaspiration (by way of obstruent gemination, according to the present hypothesis), while /r/ does not. The best explanation for the non-spirantization of the stops in (4:24) and (4:25b) is geminate inalterability, a well-attested phenomenon. Of course, the stop in (4:25b) is an underlying singleton, so the geminate inalterbility thesis would require a gemination process: obstruent gemination.

Preaspiration (of aspirated stops) and spirantization (of unaspirated /k/) are unrelated phonomena, but they do have one thing in common. When their inputs contain a singleton stop followed by /l/, /m/ or /n/, their outputs are the same as outputs derived from underlying geminate stops. Thus I conclude that all singleton stops that precede /l/, /m/ or /n/ will undergo the same processes that apply to geminate stops; and when no such processes apply, I predict that they will actually surface as geminate stops. That prediction is tested in the following section.

4.5.3 Phonetic Evidence

The phonetic data in table (4:26) is taken from an extensive set of measurements presented in Garnes (1974).

(4:26) Quantities of non-initial stops in milliseconds, Garnes (1974)

(4:26a) *vaka*	/wakʰa/	[ʋaka]	'awake'	[k]..........138	ms.
(4:26b) *vagga*	/wak:a/	[ʋak:a]	'cradle'	[k:] 241	ms.
(4:26c) *vakna*	/wakʰna/	[ʋahkna]	'waken'	[k]...........80	ms.
(4:26d) *ragna*	/rakna/	[rak:na]	'unravel'	[k:] 124	ms.

The measurements in (4:26a) and (4:26b) involve underlyingly short and long stops (respectively) followed by a vowel, so no obstruent gemination is involved; this pair serves as a "control group." Neither stop is aspirated because (4:26a) undergoes non-initial deaspiration (see §4.1 above), and (4:26b) is underlyingly unaspirated. The duration of the geminate [k:], 241 ms, was 1.75 times longer than the singleton [k], which measured 138 ms.

(4:27) Quantities of non-initial stops in ms; measurements by the author.

(4:27a)	*Þáttaka*	/θaʷtʰ:akʰa/	[θaʷhtaka]	'participation'	[k] ....114 ms.
(4:27b)	*veggur*	/wɛk:ʏr/	[ʋɛk:ʏr]	'wall'	[k:].......206 ms.
(4:27c)	*hekladði*	/hɛkʰlaθɪ/	[hɛhklaðɪ]	'crocheted'	[k] ....95 ms.
(4:27d)	*rugla*	/rʏkla/	[rʏk:la]	'bewilder'	[k:].......179 ms.

The choice of samples in (4:27) was determined by my intention to reproduce the results reported by Garnes thirty years ago. See the Appendix for waveform representations of (4:27a) through (4:27d).

Like (4:26a), (4:27a) is a singleton [k] derived from an underlying short aspirated [k^h]; (4:27b) mirrors (4:26b) as an underlying geminate surfacing unchanged as [kː]. The duration of the geminate [kː], 206 ms, was 1.8 times longer than the singleton [k], which measured 114 ms. The Garnes ratio was 1.75.

Like the last two examples in (4:26) above, (4:27c) and (4:27d) are underlyingly short stops followed by a trigger for obstruent gemination, although in this case the trigger is /l/, not /n/ as in the Garnes data. The underlyingly aspirated stop in (4:27c) has undergone preaspiration, resulting in a short [k], while the underlyingly unaspirated stop in (4:27d) has not, and has surfaced as a geminate [kː]. The duration of the stop in (4:27d), 179 ms, was 1.88 times longer than the singleton [k], which measured 95 ms. The Garnes ratio was 1.55.

I contend that the above phonological and phonetic evidence together provide a robust case for the obstruent gemination hypothesis.

Why does obstruent gemination take place? According to Calabrese (2002), certain phonological processes occur in order to enhance the perception of syllable boundaries. Obstruent gemination could be one such case, because /l/, /m/ and /n/, the triggers for obstruent gemination, are the only sonorants in Icelandic that never occur as the second element of a coda consonant cluster in an unstressed syllable. Thus, a singleton stop followed by /l/, /m/ or /n/

establishes a syllable boundary characterized by very low phonetic salience, e.g. /Vp$_\sigma$nV/, whereas a geminate stop would have the effect of enhancing the salience of the syllable boundary: [Vp:$_\sigma$nV].

4.5.4 Obstruent Gemination and Ringen (1999)

This dissertation has claimed that obstruent gemination is incompatible with Ringen's (1999) model of preaspiration and related phenomena. Before substantiating the claim, a review of the 1999 model is in order.

Ringen's central idea about aspiration stipulates that the stop surfaces *without* aspiration for one of two reasons: either it has no [spread glottis] feature; or it does have [spread glottis], but it shares that feature with another consonant (in which case neither consonant is aspirated). This idea is codified in the constraint MULTLINK; see (4:28f) below for details. Conversely, a stop surfaces *with* aspiration when it has [spread glottis], but does *not* share that feature with another consonant; the constraint that encompasses this situation (and labels it marked) is called *µptk[sg]. Table (4:28) is a list of Ringen's constraints, in order of ranking, with definitions.

(4:28) Ranked constraints, Ringen (1999). (a) » (b), (b) » (c), (c) » (d), etc.:

(a)	ID-IOobs σ1[sg]	Corresponding obstruents in the first syllable must have identical specifications for [spread glottis] in input and output.
(b)	*μptk[sg]	No moraic (i.e. geminate) [spread glottis] stops.
(c)	ID-IOμ	Corresponding consonants must have identical numbers of moras in input and output.
(d)	ID-IOobs[sg]	Corresponding obstruents must have identical specifications for [spread glottis] in input and output.
(e)	*n̥, m̥, l̥	[+cons] sonorants may not be [spread glottis].
(f)	MULTLINK	[spread glottis] must be linked to more than one consonant.
(g)	DEPROOT	Do not insert root nodes.
(h)	*r̥ [sg]	[r] may not be [spread glottis].
(i)	ID-IO(f)	Corresponding segments must have identical specifications for all features.

The tableaux in (4:29) and (4:30) below show how Ringen's model successfully captures the type of preaspiration that surfaces from a long aspirated stop, and the type that surfaces from a sequence of a short aspirated stop followed by /l/, /m/, /n/. Significantly, neither the constraints nor the underlying theory make any reference to obstruent gemination. In the tableaux that follow, the letters (a)-(i) refer to the corresponding constraints' definitions in (4:28) above.

(4:29) Preaspiration from a long aspirated stop: *takk* /tak^h:/ [t^{h}ahk] 'thanks'

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
/t^{h}ak^h:/	ID-IO obs σ 1[sg]	*μ ptk [sg]	ID-IOμ	ID-IO obs [sg]	*n̥, m̥, l̥ [sg]	MULT LINK	DEP ROOT	*r̥ [sg]	ID-IO(f)
☞ (1) [t^{h}ahk]	–	–	–	–	–	*	*	–	–
(2) [t^{h}ak^h]	–	–	!	–	–	**	–	–	–
(3) [t^{h}ak:]	–	–	–	!	–	*	–	–	*
(4) [t^{h}ak^h:]	–	!	–	–	–	**	–	–	–

In tableau (4:29), the first constraint (a) does not apply to any candidate, since /k/ is extrametrical, and does not belong to the first syllable. The next constraint (b) is violated only by candidate (4), because the others are either short (hence non-moraic) or unaspirated. Since the input is bimoraic, monomoraic candidate (2) violates constraint (c). Finally, candidate (3) is neither aspirated not preaspirated, so it violates constraint (d). The optimal candidate is (1), the preaspiration candidate.

(4:30) Preaspiration from a short aspirated stop + /l, m, n/: *rakna* /rakʰna/ [rahkna] 'swear'

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
/rakʰna/	ID-IO obs σ 1[sg]	*µ ptk [sg]	ID-IOµ	ID-IO obs [sg]	*n̥, m̥, l̥ [sg]	MULT LINK	DEP ROOT	*r̥ [sg]	ID-IO(f)
☞ (1) [rahkna]	–	–	–	–	–	–	*	–	–
(2) [rakʰna]	–	!	–	–	–	*	–	–	–
(3) [rakna]	!	–	–	*	–	–	–	–	*
(4) [rakʰ:na]	–	!	*	–	–	*	–	–	–

In tableau (4:30), the first constraint (a) is violated by candidate (3), which does not have the feature [spread glottis]. The next constraint (b) is violated by candidates (2) and (4), which have aspirated coda consonants, i.e. moraic [spread glottis] stops. Candidate (1), then, emerges as optimal.

So far, so good. This model was obviously well-crafted to yield outputs encompassing [spread glottis]. Unfortunately, its focus is so narrow that it can't handle phenomena that do not involve aspiration effects, specifically obstruent gemination. The tableau in (4:31) demonstrates the issue succinctly.

(4:31) Obstruent gemination in the context of a short unaspirated stop + /l, m, n/: *ragna* /rakna/ [rak:na] 'unravel'; see discussion in §4.5.3

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
/rakna/	ID-IO obs σ l[sg]	*μ ptk [sg]	ID-IOμ	ID-IO obs [sg]	*n̥, m̥, l̥ [sg]	MULT LINK	DEP ROOT	*r̥ [sg]	ID-IO(f)
☞ [rakna]	–	–	–	–	–	–	–	–	–
💣 [rak:na]	–	–	!	–	–	–	*	–	–

All the markedness constraints in Ringen (1999) involve [spread glottis]; the rest are faithfulness constraints. Therefore, it is easy to see how [rakna] will surface in (4:31) as the optimal candidate: it is identical to the input, so no faithfulness violations are possible, and the feature [spread glottis] is absent, so no relevant markedness constraints can apply. But the optimal candidate (☞) is not what surfaces; the actual output (💣) is [rak:na], since the stop precedes /n/ and therefore surfaces as a geminate. No re-ranking of the constraints can successfully supply an analysis for both *rakna* and *ragna*. This situation can be interpreted as another type of Chaos (cf. § 1.2.4).

The problem with Ringen (1999) is that it is too narrowly goal-oriented. Its tight focus on aspiration effects leaves no room for the obstruent gemination process.

This defect causes the model to miss the key generalization that isolates the underlying source of Icelandic preaspiration – which, after all, has been available to the careful researcher since Thráinsson (1978). The model's narrowness of scope also causes it to abandon any claim to explanatory adequacy: witness the arbitrary division of sonorant markedness constraints into *n̥m̥l̥[sg] and *r̥[sg], and the stipulation that [spread glottis] is the one and only feature in the language whose salient characteristic is a failure to surface.

4.6 Theories of length

The evidence about geminates and gemination presented in this dissertation can be used not only to support my own arguments about Icelandic phonology, but also to weigh in on how best to represent long consonants. With respect to this issue, two schools of thought prevail: the moraic or syllable-weight analysis (McCarthy & Prince 1986, Hayes 1989, Keer 1998), and the segmental or two-root theory, proposed in Selkirk (1990) and later elaborated in Vago (1992), Ko (1998) and Ringen & Vago (2002). This section touches upon those schools of thought, and shows how the Icelandic phenomenon of consonant lengthening supports the two-root theory of length.

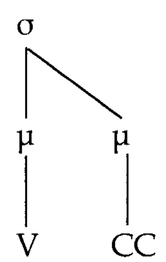
4.6.1 Coda Structure in Mora Theory

Moras were originally posited as phonological constructs that distinguish light syllables from heavy syllables. Weight is typically associated with stress, tone, and other prosodic phenomenona. Mora theory stipulates that onset consonants have no effect on phonological weight (Hyman 1985), so as far as consonants go, a heavy syllable with a short vowel is defined in terms of mora theory by the presence of a coda consisting of a consonant cluster. A syllable with no coda, or a syllable with a singleton consonant coda, is light.

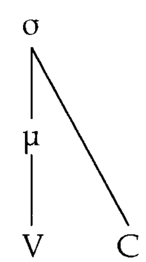
(4:32) shows how heavy and light syllables are distinguished in terms of coda structure. Nuclear structure also affects syllable weight, but I will not examine vowel phenomena here, and I will restrict all examples in this section to nuclei with short vowels.

(4:32) Heavy and Light Syllables Distinguished by Coda Structure

(4:32a) Heavy Syllable, Moraic Coda



(4:32b) Light Syllable, Non-Moraic Coda



(4:32a) shows that a heavy syllable is bimoraic; the short V provides one μ, and the cluster coda provides the other. By contrast, in (4:32b) the light syllable is monomoraic because the short V again supplies a μ, but the singleton coda is non-moraic.

4.6.2 The Moraic Theory of Length

Just as a coda consonant cluster is mora-bearing in traditional mora theory, a geminate consonant is represented in the moraic theory of length by a single root node associated with a mora. This situation is shown in shown in (4:33).

(4:33) Representation of a geminate consonant under the moraic theory of length.

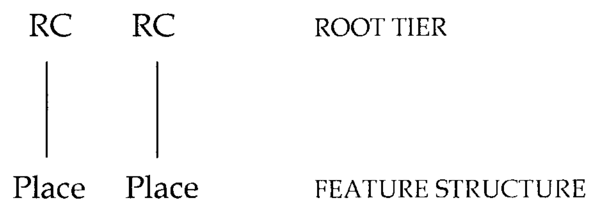
σ
|
μ
|
[±consonantal, ±sonorant]

I will address (4:33) from the bottom up. First, [±consonantal, ±sonorant] makes reference to the Feature Geometry model that I presented in (3:2). It allows for all possible phonetic outputs of consonants. Moving up the prosdic hierarchy, the mora gives underlying weight to the segment, and the phonetic expression of this weight is the temporal expression of pronunciation length, i.e the singleton ~ geminate distinction demonstrated in (4:26a) and (4:26b).

4.6.3 The Two-Root Theory of Length

As discussed in §4.4.1, the two-root theory of length can be encapsulated in (4:34).

(4:34) *Representation of a geminate consonant under the two-root theory of length.*



The only successful account of Icelandic preaspiration (Selkirk 1990) makes use of the two-root theory, which is the simplest model for geminate consonants. This fact does not by itself indicate which theory of length is best. However, obstruent gemination does provide evidence that geminates are bisegmental.

The argument goes like this: the [h] of preaspiration is a segment, so when obstruent gemination causes /t^{h}n/ to surface as [htn], the input is bisegmental but the output is trisegmental. In exactly the same manner, when obstruent gemination causes /tn/ (with no aspiration) to surface as [tːn], the input is bisegmental and the output is trisegmental. Assuming that the singleton [n] is monosegmental, then the geminate [tː] must be bisegmental. The bisegmentality of geminates is, of course, the essence of the two-root model of length. Therefore, based on the interaction of preaspiration with obstruent gemination, data from the Icelandic language provides what I believe is conclusive support for the two-root model of consonant length.

Chapter Five

Aspiration, Preaspiration, Sonorant Devoicing, and Deaspiration in Dynamic Phonology

5.1 Introduction

In order to provide a unified account of aspiration, preaspiration, sonorant devoicing, and deaspiration, I return to Dynamic Phonology (DP), the theory currently under development by Andrea Calabrese that attempts to capture the most desirable elements of both derivational phonology and OT, while avoiding their drawbacks.

For an in-depth look at DP, please refer to section 1.3; here is a brief recap of the theory. Dynamic phonology is derivational. It employs both rules and constraints, some of which are universal and some language-specific. Universal constraints can be "switched off," and each language is distinguished by its unique set of "switched off" universal constraints. A rules applies if its structural description is met; its output is invariable, and determined by the specific rule involved. A constraint applies if it is both active (i.e. not switched off) and violated. If a constraint does apply, repair mechanisms take effect. In addition, the theory assigns "premium value" to various constructs – dynamic phonology's answer to the faithfulness constraints of OT. A premium value assignment confers upon a construct the tendency to resist deletion. The set of premium-value constructs varies for each language.

According to my interpretation of dynamic phonology, some of the repair mechanisms available in Icelandic are listed in (5:1).

(5:1) Repair mechanisms, Icelandic

- delete association lines
- add association lines

In addition, I posit a premium value assignment for Icelandic in (5:2):

(5:2) Premium value assignment, Icelandic

- Premium value: [spread glottis]

Finally, I suggest a set of constraints for Icelandic in (5:3):

(5:3) Constraints that are active in Icelandic

(5:3a) [spread glottis] is marked in an unstressed syllable

(5:3b) [spread glottis] is marked when attached to more than one root

The repair mechanisms listed in (5:1) are uncontroversial, and have been treated at length in terms of autosegmental phonology (e.g. Clements and Hume 1996).

The premium value assignment, (5:2), protects [spread glottis] because the only other glottal distinction physiologically available for obstruents – voicing – disappeared from Icelandic in the Middle Ages.

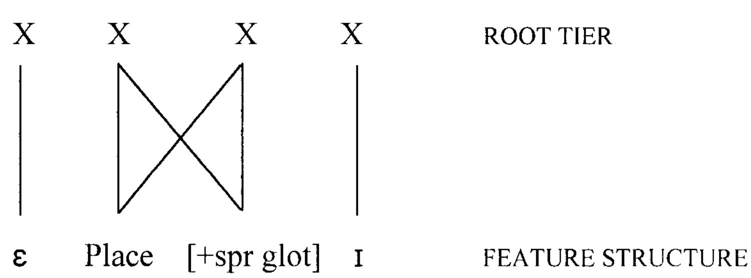
The constraints in (5:3) need to be "grounded" according to the definition of Kager (2002:11): "phonetic evidence from production or perception should support" any such constraint.

Constraint (5:3a) expands on the implicational universal that [+spread glottis] only occurs in the context of [-spread glottis], which means that some languages include unaspirated stops in their phonemic inventories while excluding aspirated stops, but no languages include aspirated stops in their phonemic inventories while excluding unaspirated stops. Thus, aspirated stops are marked in general, and in particular they are marked in Icelandic in unstressed syllables. Constraint (5:3b) exists because of the obvious production problems associated with *[p^hp^h].

5.2 Preaspiration Derived from a Geminate Aspirate

Given the specifications in (5:1) through (5:3), the concepts of dynamic phonology can be applied to preaspiration. Following Selkirk's insights (presented above in §4.4.1), an underlying geminate aspirate such as the /k^h:/ in *ekki* 'not' can be represented as shown in (5:4):

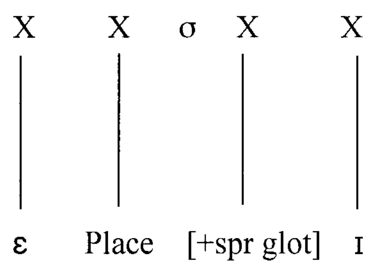
(5:4) Underlying representation of *ekki* /ɛk^hːɪ/ 'not', following Selkirk (1990)



The representation in (5:4) violates constraint (5:3b), in that [spread glottis] is attached to more than one root, and therefore needs repair. To determine which repair will eliminate the violation of (5:3b), it is first necessary to list all the logically-possible output forms of (5:4); they are shown in (5:5):

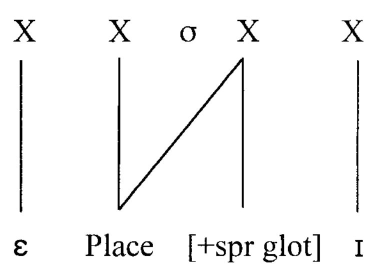
(5:5) Possible output forms of (5:4); syllable boundaries are represented by "σ".

(5:5a)



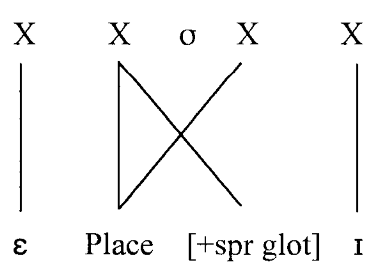
Violates Constraint (5:3a)

(5:5b)



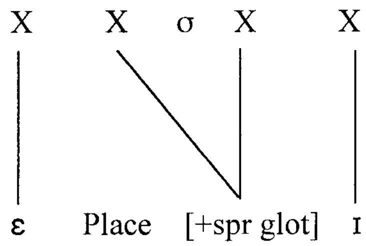
Violates Constraint (5:3a)

(5:5c)



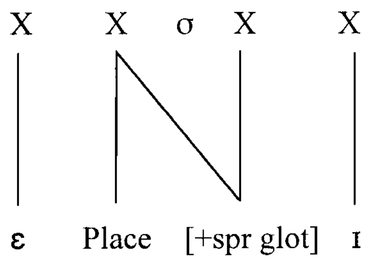
Unpronounceable

(5:5d)



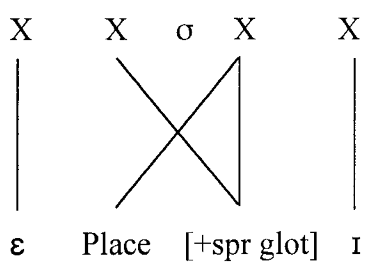
Violates constraint (5:3b)

(5:5e)



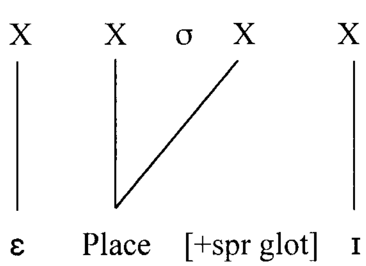
Violates constraint (5:3b)

(5:5f)



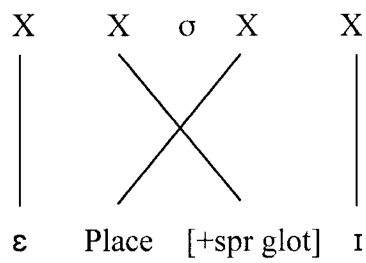
Violates constraint (5:3b)

(5:5g)



Violates (5:2), premium value

(5:5h)



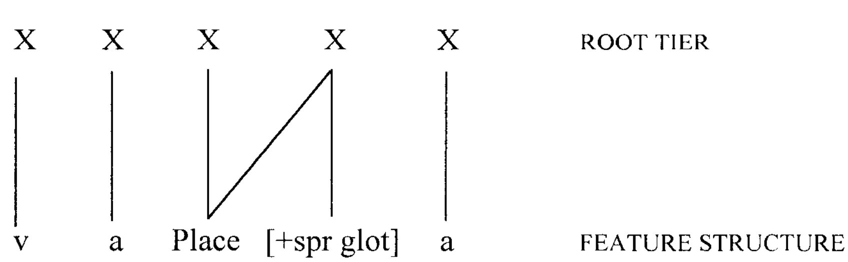
No violations; output

Of all the possible outputs, (5:5a) and (5:5b) violate constraint (5:3a), since the association line connects [spread glottis] with the second of the two root nodes, which is not part of the initial, stressed syllable. (5:5d), (5:5e), and (5:5f) violate constraint (5:3b), since the association lines connect [spread glottis] to both root nodes. (5:5c), an aspirated stop followed by an otherwise identical unaspirated stop, is unpronounceable. (5:5g) eliminates [spread glottis] altogether, and so violates (5:2), the premium value assignment attributed to [spread glottis]. (5:5h), bisegmental preaspiration, thus emerges as the output.

5.3 Sonorant Devoicing with Deaspiration

Devoicing occurs when a sonorant precedes an aspirated stop. An example of sonorant devoicing can be seen in (5:6):

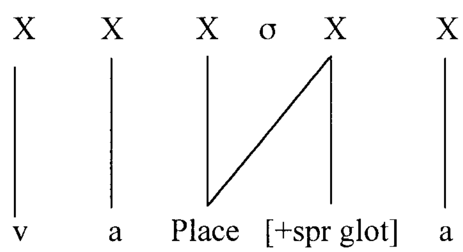
(5:6) Underlying representation of *vanta* /vant^{h}a/ [van̥ta] 'lack'



The representation in (5:6) violates constraint (5:3a), in that [spread glottis] is the onset of an unstressed syllable, and therefore needs repair. To determine which repair will eliminate the violation of (5:3a), it is first necessary to list all the logically-possible output forms of (5:6); they are shown in (5:7).

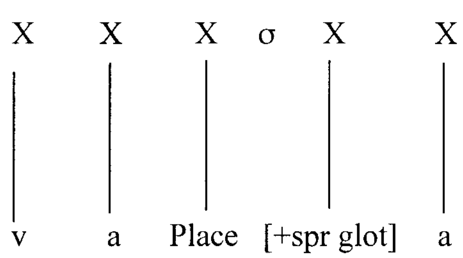
All possible output forms of (5:6) are shown in (5:7) ; syllable boundaries are represented by "σ".

(5:7a)



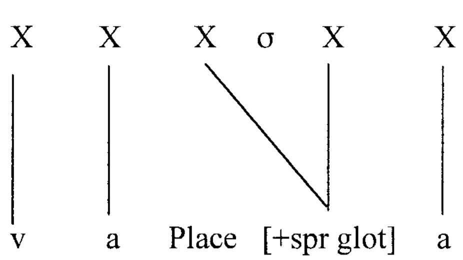
Violates constraint (5:3a)

(5:7b)



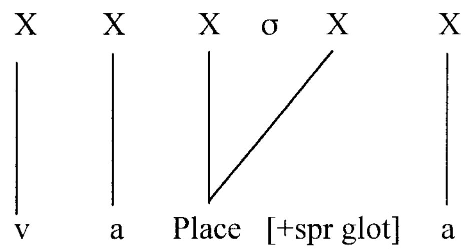
Violates constraint (5:3a)

(5:7c)



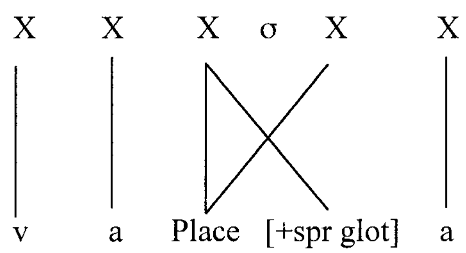
Violates constraints (5:3a), (5:3b)

(5:7d)



Violates premium value (5:2)

(5:7e)



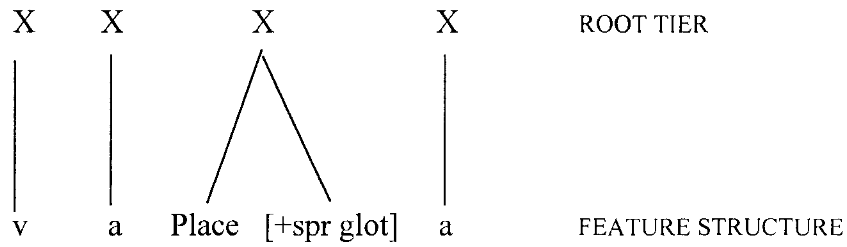
No violations; surfaces.

Of all the possible outputs, (5:7a) through (5:7c) violate constraint (5:3a), since the association line connects [spread glottis] with the second of the two root nodes, which is not part of the initial, stressed syllable. (5:7c) violates constraint (5:3b), since the association lines connect [spread glottis] to both root nodes. (5:7d) violates (5:2), the premium value assignment attributed to [spread glottis]. (5:7e), with devoicing in the first relevant segment, thus emerges as the output.

5.4 Aspiration

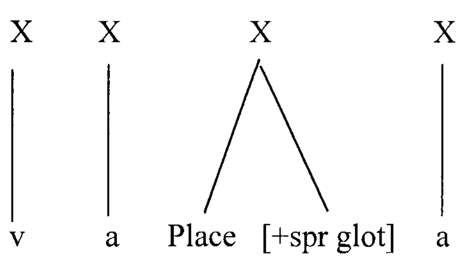
Aspiration occurs in unstressed (non-initial) syllables in the northern dialect of Icelandic. An example of aspiration can be seen in (5:8):

(5:8) Underlying representation of *vaka* /wak^{h}a/ [ʋa:k^{h}a] 'awake'



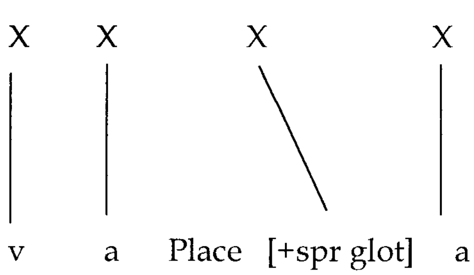
The representation in (5:8) violates constraint (5:3a), in that [spread glottis] is associated with the onset of an unstressed syllable, and therefore needs repair. To determine which repair will eliminate the violation of (5:3a), it is again necessary to list all the logically-possible output forms of (5:8); they are shown in (5:9).

(5:9a)



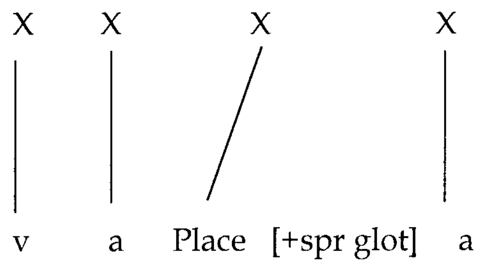
Violates (5:3a)

(5:9b)



Violates (5:3a)

(5:9c)



Violates (5:2), premium value

In this case, all three output possibilities incur violations, so the UR simply surfaces without undergoing any changes, and the aspiration is pronounced as in (5:8).

Conclusion

This dissertation builds upon the work of Thráinsson and others, using an integrated system of rules and constraints, to account for the following phonological effects of Icelandic:

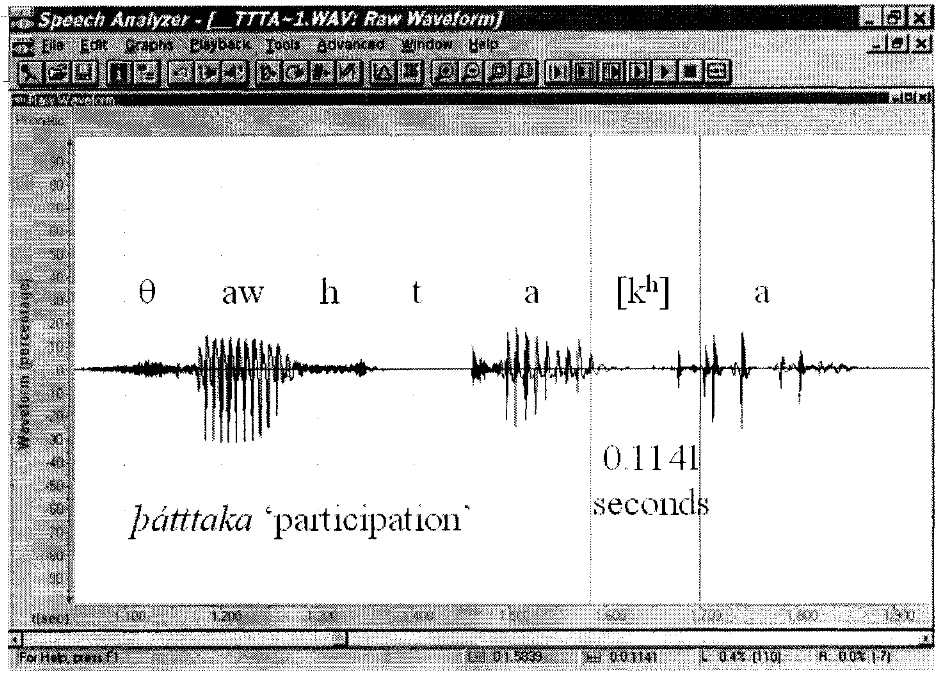
- preaspiration
- the occurrence of obstruent gemination
- the non-occurrence of obstruent gemination in the case of preaspiration
- vowel-length anomalies
- sonorant devoicing

With just a few rules and repair mechanisms, two well-grounded constraints, and a single premium-value assignment, the DP approach provides the first-ever unified explanation for aspiration, preaspiration, deaspiration and devoicing in Icelandic.

The concept within phonological theory of an integrated system of rules and constraints such as DP is nothing new. I contend that such an approach - rules coupled with constraints - should be aggressively pursued by phonologists of every persuasion. Calabrese's model is a good start.

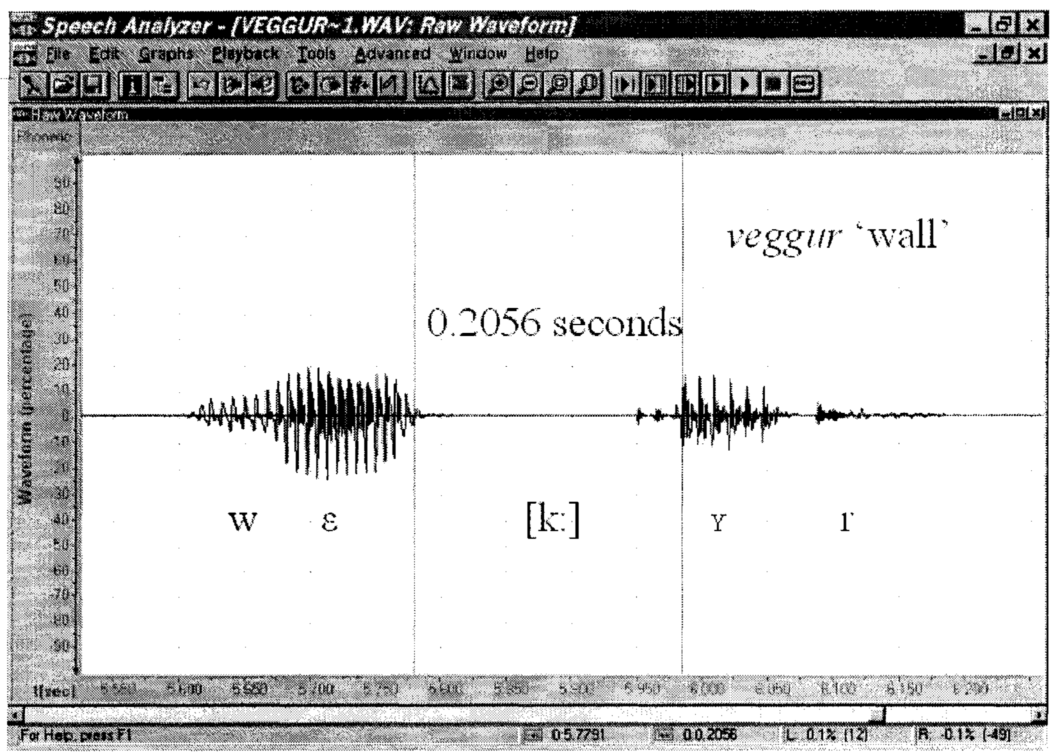
Appendix

(4:27a)



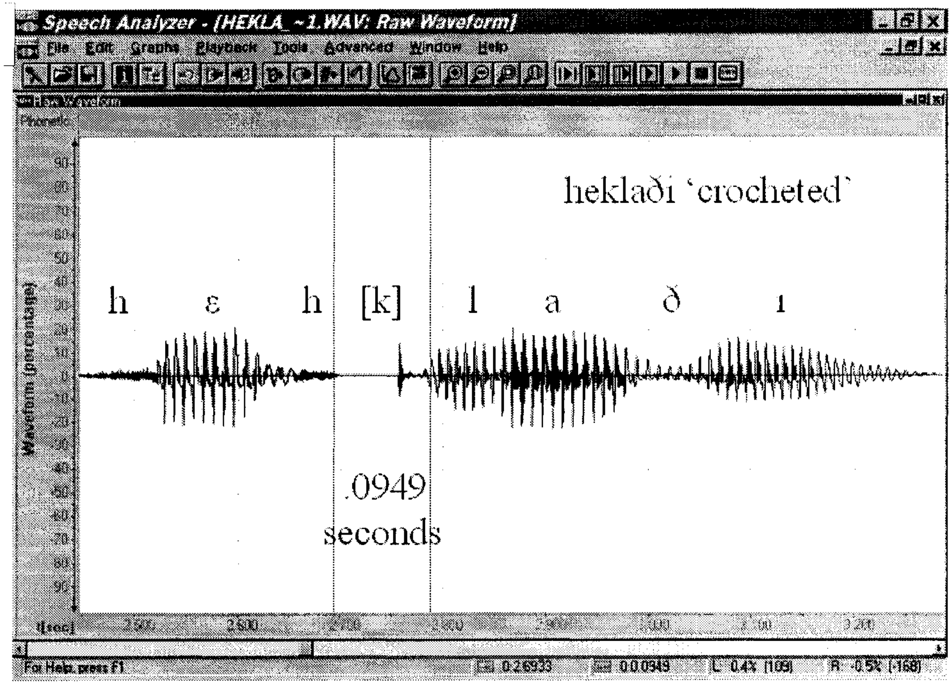
[k^h], *an intervocalic short aspirated stop, 0.114 seconds*

(4:27b)



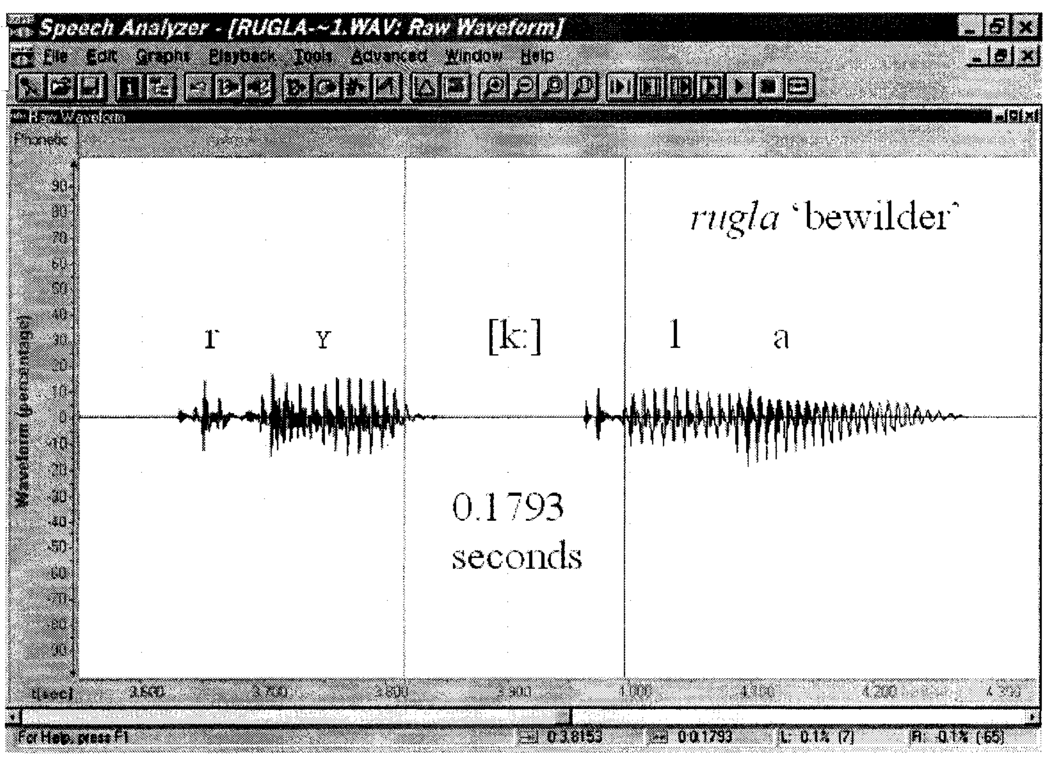
[k:], *an intervocalic long unaspirated stop, 0.206 seconds*

(4:27c)



[k] - *a short preaspirated stop followed by* [l] - *0.095 seconds*

(4:27d)



[k:], *a long unaspirated stop followed by* [l], *0.179 seconds*

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