UNIVERSITY OF CALIFORNIA

Los Angeles

Phonetic Effects in Swedish Phonology:

Allomorphy and Paradigms

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Linguistics

by

Ingvar Pekka Magnus Löfstedt

2010

A NOTE TO THE READER

The following text is a revised version of my UCLA PhD thesis with the same title, which was filed in March 2010.

Some changes merit note. In the March 2010 version, I did not have access to *Svenska Akademiens grammatik* (Teleman et al. 1999; henceforth *SAG*). In the current version of the thesis, I refer to this definitive grammar of contemporary Swedish. The March 2010 version referred to Holmes & Hinchliffe 1994. Significantly, *SAG* included more ineffable forms than Holmes & Hinchliffe 1994. Chapter 5 has now been expanded to include all of the ineffable forms of *SAG.*

Also, the Swedish verbal paradigms are organized slightly differently in *SAG* as compared to Holmes & Hinchliffe 1994. For this reason, the listings of paradigms in the appendices have been changed. The numbers in the statistical analysis have changed slightly, but the overarching patterns remain unchanged.

Remaining references to Holmes & Hinchliffe 1994 have been replaced by references to Holmes & Hinchliffe 2003.

Section 5.7, 'Two clarifications regarding the frequency index', is new.

Section 6.3.4, 'A potential confound', has been rewritten. This was done to improve clarity.

Remaining changes are editorial in nature. I added relevant citations, I fixed typographical errors, and improved unclear phrasing.

Los Angeles, August 2010

TABLE OF CONTENTS

ACKNOWLEDGMENTS

The present thesis is the result of collaborative work among several individuals. I wish to thank the four members of my committee. I am profoundly grateful to my two co-chairs Bruce Hayes and Kie Zuraw. The thesis could not have been written without their guidance; no aspect of my proposals escaped their attention. My co-chairs and I agreed that the perceptual claims in the thesis required experimental verification: Megha Sundara provided me with a solid background in experiment design, and provided guidance in that domain. Donka Minkova drew my attention to earlier phonological proposals, which were close to the spirit of my own proposals. All four committee members are scholars of the highest order, and it was an honor to work under their guidance.

Two phonologists external to the committee deserve credit for crucial assistance and insight. I am referring to Donca Steriade and Colin Wilson. The reader will immediately note that the present thesis relies on Donca Steriade's work on the Perceptual Map; without this development, the thesis could not have been formalized. She was as actively involved in the creation of this thesis as the committee members.

I had the pleasure of studying under the guidance of Colin Wilson over the summer of 2007. The formalism for the allomorphy of the Swedish non-neuter definite article was created during this summer research mentorship.

I also thank Morris Halle and Michael Kenstowicz for providing me with a solid background in Phonology.

Practical aspects of the thesis required assistance from specialists. Philip Ender of the ATS Statistical Consulting Group at UCLA provided statistical assistance. Roy Becker helped me calculate perceptual distances between vowels, and provided relevant

references on vowel spaces. Nick LaCasse wrote the MATLAB script that was used in all the experiments. Dennis Paperno assisted me with the Russian National Corpus. Jason Bishop gave me access to LEXESP, and Ingrid Norrman assisted me with the data on Spanish diphthongization and ineffability.

Renate Raffelsiefen generously sent me a copy of her 2002 manuscript. Björn Lindblom generously sent me a copy of Thorén's 2008 dissertation and referred me to other literature on Swedish vowels.

The Swedish community in Los Angeles provided great assistance. I thank all the individuals who let themselves be recorded, and who took part in the perception experiments.

My father Bengt Löfstedt had an eye for linguistic curiosities, as my mother Leena Löfstedt still does. Their linguistic appreciation left their mark, and many of the curiosities of Swedish phonology and morphology were first brought to my attention by them.

My studies at UCLA were made enjoyable thanks to the company of numerous pleasant characters: I wish to thank all the professors, all the graduate students, and all the staff for being supportive and helpful throughout my stay.

VITA

February 16, 1970	Born, Uppsala, Sweden
1991	BA, Linguistics & Philosophy University of California, Los Angeles
1993-95	MIT Presidential Fellowship
1995	MS, Linguistics Massachusetts Institute of Technology
1998-2004	Lecturer Universidade do Minho, Portugal
2004	Research Assistant University of California, Los Angeles
2006-2010	Teaching Assistant University of California, Los Angeles
2006-2007	UCLA Linguistics Department Fellowship
2006-2009	Lecturer (Summer session) University of California, Los Angeles
2007-2008	UCLA Linguistics Department Fellowship
2007	Summer Research Mentorship Program
2008	UCLA Linguistics Department Award
2008-2009	UCLA Graduate Division Dissertation Year Fellowship
2009	Lecturer Pomona College

PUBLICATIONS AND PRESENTATIONS

1992. Swedish Segment Length and Structure Preservation. *Studia Linguistica* 46:93-127.

1995. Swedish Pitch Accents as Lexically Marked High Tones. *MIT Occasional Papers in Linguistics* 6.

2007. Intonational Phonology of Georgian. Workshop on Intonational Phonology: Understudied or Fieldwork Languages. A satellite meeting of ICPhS, Saarbruecken, Germany. (with Sun-Ah Jun and Chad Vicenik)

2007. Intonational Phonology of Georgian. *UCLA Working Papers in Phonetics* 106:41-57. (with Sun-Ah Jun and Chad Vicenik)

2007. Allomorphy as Optimization of Perceptual Salience: the Swedish Non-Neuter Definite Article. mfm 15 (Manchester Phonology Meeting).

2007. Perceptually Driven Allomorphy. Poster presented at NELS 38 (Northeastern Linguistics Society), University of Ottawa.

2008. On Frequency-Sensitive Ineffability. Talk presented by teleconference at Moscow State University for the course Some Applications of Mathematical Methods in Linguistics.

2008. Ineffability and Frequency in Swedish. Talk presented at Workshop on Categorical Phonology and Gradient Facts at GLOW 31 (Generative Linguistics in the Old World), Newcastle University.

2008. Perceptually driven allomorphy: The Swedish non-neuter singular definite article. *NELS 38: Proceedings of the 38th meetings of the North East Linguistics Society.*

2010. Allomorphy driven by perceptibility. Talk presented at LSA 2010 Annual Meeting (Linguistic Society of America), Baltimore, MD.

ABSTRACT OF THE DISSERTATION

Phonetic Effects in Swedish Phonology:
Allomorphy and Paradigms

by

Ingvar Pekka Magnus Löfstedt

Doctor of Philosophy in Linguistics

University of California, Los Angeles, 2010

Professor Bruce Hayes, Co-chair

Professor Kie Zuraw, Co-chair

The present thesis presents five theoretical chapters and one experimental chapter. The first two chapters involve maintenance of distinctness in different parts of the grammar: Chapter 1 argues that it is preferable for tautoparadigmatic affixes (including null suffixes) to be relatively distinct with respect to each other. This penalizes similarity, not just homophony. This chapter is motivated by the distribution of the non-neuter definite article in Swedish, which features an epenthetic schwa when the suffix /n/ would otherwise be non-salient. Chapter 2 argues that identical sequences are avoided (haplology), but so are highly similar sequences. This chapter is motivated by the failure of the suffix /ən/ to surface after trochees ending in /an/.

Chapters 3 and 4 involve correspondence between instances of the same morpheme: salient alternations are avoided. Chapter 3 argues that less salient alternation of consonant length is preferred to more salient alternation of consonant length. This means that degemination is more likely to occur in those contexts where degemination is less noticeable. This is motivated by the patterning of the geminate-initial supine, participle, preterite, and neuter suffixes. These suffixes are shortened after unstressed vowels and after consonants, where the degemination is non-salient. Chapter 4 argues that minimal alternation of vowel quality is preferred within paradigms. The more distant two sounds are, the less likely their correspondence is. Failed alternation results in paradigm gaps and underrepresentation of the tense/lax pairs [ɑ,a] and [ʉ, ɵ] in tenseness-shifting paradigms. These vowel pairs are more distant than other tense/lax vowel pairs; so their correspondence is dispreferred in the inflectional system.

Chapter 5 relates unfaithful mapping to morpheme frequency. Severity of penalty of unfaithful mapping declines as the frequency of the stem increases. Frequent words can be paradigmatically altered to a greater extent than infrequent words.

Chapter 6 provides experimental support for the claims in Chapters 1-5.

Chapters 7, 8, and 9 are a conclusion, appendices, and references, respectively.

0 Introduction

0.1 Overview

The present study provides a perceptual account of some aspects of Swedish phonology and morphology. The work is an extension of recent work on phonetically grounded phonology (Fleischhacker 2005; Hume & Johnson 2001; Hayes, Kirchner & Steriade 2004; Kawahara 2006; Wilson 2006), with an excursus on frequency effects (Bybee 2001, Coetzee 2009).

The central claim is that morphophonology (allomorphy and haplology) and correspondence (paradigm structure) make reference to the Perceptual map (henceforth, P-map; Steriade 2001). An additional claim is that frequency effects are part of the grammar proper: Underlying Representations include frequency indices, and faithfulness constraints (Prince & Smolensky 1993/2004) refer to these indices.

Four constraints are posited:

(1) *NONDIST MORPH (m_i , m_j/K)

*REPETITION (SEQ_I-SEQ_J)

IDENT [Long C] / K

*MAP (X,Y)

What follows is a brief introduction to each one in turn, in the order they are discussed in the thesis.

Chapter 1 introduces the constraint family *NONDIST MORPH (m_i,m_j/K). This constraint penalizes non-distinct morphemic exponences m_i and m_j in a context K. The less distinct the exponence of a morpheme is compared to another tautoparadigmatic morpheme, the more severe a penalty is accrued. That is, morphemes are preferably distinct from each other. The ranking of distinctness is obtained from the P-map, and

the information is projected into the grammar in the form of ranked violable constraints of Optimality Theory (Prince & Smolensky 1993/2004).

For example, take the allomorphy of the Swedish non-neuter definite suffix. It varies according to the preceding sound, depending on whether it is nasal, lateral, or vocalic:

(2)

CONTEXT	NON-NEUTER DEFINITE
N_#	ən
L_#	ən or n
V_#	n

This mirrors gradient perceptibility of the morpheme /n/ (the non-neuter definite suffix), and in particular the morpheme's confusability with respect to the morpheme ∅ (a null marker of non-definiteness). The two morphemes have the following relative degrees of confusability in post-nasal, post-lateral, and post-vocalic contexts. Larger font size signifies low confusability (i.e., high perceptual distinctiveness); smaller font size signifies higher confusability (i.e., low perceptual distinctiveness):

(3)

Context / Morphemes	N_#	L_#	V_#
n/∅	n/∅	n/∅	n/∅

By virtue of a principle of projection from the P-map to the grammar, the following constraint ranking is derived:

(4) *NONDIST MORPH (n,∅/N_#)

≫ *NONDIST MORPH (n,∅/L_#)

≫ *NONDIST MORPH (n,∅/V_#)

This ranking, together with additional independently motivated constraints, can be used to analyze the allomorphy of the Swedish non-neuter definite article.

Chapter 2 introduces the constraint family *REPETITION (SEQ_I-SEQ_J). This constraint penalizes the repetition of similar strings. It is conceptually motivated by the phenomenon of repetition blindness, and derives haplology in the Swedish non-neuter definite paradigm. Bisyllabic trochee stems (ˈσ σ) ending in [ən] and [an] form the non-neuter singular definite through haplology, while stems ending in [ɔn] receive an overt suffix:

(5)

	STEM	NON-N SG. DEFINITE	NOTE
[ən]-final trochee	[ˈmyrtən]	[ˈmyrtən]	*haplology*
[an]-final trochee	[ˈvɛntan]	[ˈvɛntan]	*haplology*
[ɔn]-final trochee	[ˈmɔrgɔn]	[ˈmɔrgɔnən]	*overt sfx*

The important point to note is that the haplology is not only being triggered by identical strings ([ən-ən]), but also by similar strings ([an-ən]). That is, the haplological effect is gradient. Assuming that the sound pair [ɔn]/[ən] is less confusable (more distinct) than [an]/[ən], we have the following scale of perceptual distinctness:

(6) Δ (ɔn, ən)

> Δ (an, ən)

> Δ (ən, ən)

The grammar accesses this scale of relative distinctness, and generates a ranking of *REPETITION constraints.

(7) *REPETITION (ən-ən)

≫ *REPETITION (an-ən)

≫ *REPETITION (ɔn-ən)

These constraints penalize the repetition of similar sequences. The more similar a sequence is, the more highly ranked the constraint is. This ranking of *REPETITION constraints, combined with other independently motivated constraints, generates the Swedish pattern of gradient haplology.

Chapter 3 introduces the constraint family IDENT [LONG C] / K. This constraint family penalizes degemination in context K of a consonant C, where C is marked as long in UR. The Swedish suffixes that mark the participle, supine, and preterite are geminate-initial when they follow a stressed vowel:

(8)

STEM	PARTICIPLE	SUPINE	PRETERITE	GLOSS
truː	ˈtru[dː][1]	ˈtru[tː]	ˈtru[dː]ə	'believe'

In this context, they surface faithfully.

However, they begin with a short consonant when they follow a consonant or an unstressed vowel:

(9)

STEM	PARTICIPLE	SUPINE	PRETERITE	GLOSS
ˈvɛːg	ˈvɛːg[d]	ˈvɛːg[t]	ˈvɛːg[d]ə	'weigh'
ˈviːl	ˈviːla[d]	ˈviːla[t]	ˈviːla[d]ə	'rest'

These suffixes are marked as long in UR (Teleman 1969), and the grammar makes reference to the perceptibility of degemination, here represented by means of the P-map (Steriade 2001):

[1] The vowel changes quality when it is short, but I will abstract away from this detail when it is irrelevant, for expositional clarity.

(10)

Context / Sounds	V_ +stress	V_ -stress	C_
C:/C	C:/C	C:/C	C:/C

Font size denotes perceptual distinctness. The long and short consonants are highly distinct after a stressed vowel, but less so after a stressless vowel or after a consonant. The relative perceptual distinctness in the P-map determines the ranking of degemination constraints:

(11) IDENT [LONG C] / $V_{+stress}$ _

≫ IDENT [LONG C] / $V_{-stress}$ _, IDENT [LONG C] / C _

This ranking, together with other independently motivated constraints, generate the correct patterns.

Chapter 4 discusses the constraint family *MAP (X,Y) in Swedish phonology. The constraint, developed by Zuraw 2007, rules out correspondence of non-identical segments. The ranking of the *MAP (X,Y) constraint makes reference to the P-map: the greater the perceptual distance between the correspondents, the greater the penalty. The present thesis adds two refinements to the *MAP (X,Y) proposal. The first is the distinction between *MAP (X,Y)/+INFL and *MAP (X,Y)/-INFL. The former constraint penalizes unfaithful correspondence in inflectional forms; the latter does the same in non-inflectional forms. This distinction is motivated by the different correspondence possibilities in the inflectional and derivational systems of Swedish. The correspondence between vowels [ɑ] and [a] is generally disallowed in the inflectional

system.[2] The word *l[aː]t* is famously ineffable in the neuter, since the preferred candidate **l[a]tː* features the problematic vowel correspondence (Raffelsiefen 2002). However, the correspondence between vowels [ɑ] and [a] is allowed in the derivational system, including nicknames and productive suffixation of the morpheme *-isk* (Eliasson 1985). So the name *j[aː]n* and the nickname *j[a]nːə* feature the problematic correspondence, as does the stem *bals[a]m* and the suffixed form *bals[aː]mɪsk*.

Chapter 5 features a second refinement of the constraint family *MAP (X,Y): frequency indices on the constraints. Specifically, *MAP (X,Y)/+INFL is sensitive to the frequency of the stem morpheme in Swedish. Returning to the example of [ɑ]/[a] correspondence, recall that it is ruled out in the inflectional system, generating a paradigm gap rather than the neuter **l[a]tː* for the stem *l[aː]t*. This contrasts with the stem *gl[aː]d* 'happy', which in fact does feature a neuter form, namely *gl[a]tː*. There is no gap in this word's paradigm. The crucial difference is morpheme frequency: the word 'happy' has a much higher frequency than the word for 'lazy'. The unfaithful mapping in the rare word is penalized more severely than the unfaithful mapping in the common word. Concretely, the constraint *MAP (ɑ,a)/+INFL comes in different forms, depending on frequency indices. In this present case, consider *MAP(ɑ,a)/+INFL (827,000) and *MAP(ɑ,a)/+INFL (2,270,000), where the numbers 827,000 and 2,270,000 are the frequency indices of the words 'lazy' and 'happy', respectively. The grammar ranks a given *MAP constraint by order of the frequency index: A low index results in a high ranking. *MAP(ɑ,a)/+INFL (827,000) is ranked higher than *MAP(ɑ,a)/+INFL (2,270,000). The ineffability is formally captured by having M-PARSE—the constraint that rules out ineffability (Prince & Smolensky

[2] This is a simplification: it is allowed if the frequency index is sufficiently high. This is the topic of Chapter 5, discussed below.

1993/2004)—between these two *MAP constraints. Other examples of frequency-driven ineffability in Swedish are provided, and are formalized in a similar fashion. Also, gaps in Spanish verbal paradigms are shown to be driven by frequency.

Chapter 6 discusses experiments, whose purpose is to establish the P-maps assumed in Chapters 1 through 4. The experiments involve detection of [n] in various contexts; distinguishing [ən] from [an] and from [ɔn]; repetition blindness triggered by [ənən], [anən], and [ɔnən]; perceptibility of degemination; and perceptual distances between vocalic tense/lax pairs.

Chapters 7, 8, and 9 are a conclusion, appendices, and references, respectively.

0.2 Vowel inventory and phonotactics

The following thesis makes reference to Swedish sounds and Swedish phonotactics, so a review is in order.

Swedish features nine long vowels [iː, yː, ʉː, eː, øː, ɛː, ɑː, oː, uː] and eight short vowels [ɪ, ʏ, ɵ, ɛ̞, ø̞, a, ɔ, ʊ].[3] The different number of long and short vowels is the result of the neutralization of short [e̞] and short [ɛ̞], although some dialects maintain the distinction between these vowels. Elert 1997 notes that this sound is reduced to schwa [ə] in stressless position. I will assume this convention in my transcriptions, although to my ears the stressless vowel sounds more like [ɛ]. Also, mid front vowels are slightly lowered before /r/ (Elert 1979), an allophonic detail that I will ignore in the

[3] I generally follow Elert's transcriptions (Elert 1997). He uses omega where I use short [ʊ], and he uses long [ʊ] where I use long [u]. Omega is no longer in the IPA. I transcribe with long [u] simply because this is closer to how it sounds to my ears. For more details on Swedish phonetics, see Elert (1966, 1970, 1981) and Malmberg (1971).

present study. Elert (1997:24) notes that 'the short vowels are in general more open and can be placed more centrally in the vowel chart than the long ones.'[4]

Basic Swedish phonotactics merit a review as well. Consonant length is underlying; vowel length is derived (Linell et al. 1971, Eliasson & LaPelle 1973, Hellberg 1974, Löfstedt 1992, Riad 1992). A stressed syllable has one and only one long segment. Words can also feature lexically marked vowel quality (Linell 1978), particularly the vowels [ɑ, a, ʉ, ɵ], which will be discussed in chapters 4 and 5.

If the coda-initial (or coda-unique) consonant is marked as long in UR, it surfaces as long, and the vowel is short.

(12)	SCHEMA	($^{\prime}C_0VC$ː)#	→	($^{\prime}C_0VC$ː)	
	EXAMPLE	/vɛgː/	→	[vɛgː]	'wall'

A vowel is long iff it is in a stressed open syllable (Löfstedt 1992, Riad 1992), modulo word-final extrametricality, which applies to non-geminate consonants.

(13)	SCHEMA	($^{\prime}C_0V$)#	→	($^{\prime}C_0V$ː)	
	EXAMPLE	/lɛ/	→	[lɛː]	'shelter from wind'
	SCHEMA	($^{\prime}C_0V$)C#	→	($^{\prime}C_0V$ː)C	
	EXAMPLE	/vɛg/	→	[vɛːg]	'road'

In closed syllables, vowels are short. This applies to syllables ending in a geminate consonant; geminates are never extrametrical word-finally, and they are ambisyllabic intervocalically.

[4] The translation is mine [IL]. The original reads: 'De korta vokalerna är i allmänhet mer öppna och kan placeras mer centralt i vokalfyrsidingen än de långa.'

(14)	SCHEMA	(ˈC_0VCː)#	→	(ˈC_0VCː)	
	EXAMPLE	/vɛgː/	→	[vɛgː]	‘wall’
	SCHEMA	ˈC_0VCːV	→	ˈC_0VCːV	
	EXAMPLE	/lɛ̥gːa/	→	[lɛ̥gːa]	‘lay’

Vowels are also short in syllables ending in two or more consonants.

(15)	SCHEMA	(ˈC_0VC)C#	→	(ˈC_0VC)C	
	EXAMPLE	/slɛ̥kt/	→	[slɛ̥kt]	‘family’

In unstressed syllables, all segments are short, whether the syllable is open or closed.

(16)	SCHEMA	C_0v̆	→	C_0 v̆	
	EXAMPLE	/bəˈvis/	→	[bəˈviːs]	‘proof’
	SCHEMA	C_0v̆C	→	C_0v̆C	
	EXAMPLE	/føˈmo/	→	[føˈmoː]	‘manage’

A vowel must be short in a closed syllable or in an unstressed syllable. It cannot be long in these environments.

The essential pattern of Swedish segment length involves a biconditional on segment length (Löfstedt 1992):

(17) $\sigma_{\mu\mu} \leftrightarrow [+\text{stress}]$

A long vowel is bimoraic; a short vowel and a long (geminate) consonant are monomoraic. A result of this biconditional is that either the vowel is long, or the coda-initial consonant is long; it is never the case that both are long.

1 The suffix /n/ and *NONDIST MORPH

1.1 Introduction

The Swedish non-neuter definite article has two allomorphs, /n/ and /ən/ (Teleman 1969, Eliasson 1972, Linell 1972, Hellberg 1974, Riad 2003) . Langacker's (1968) influential analysis of English allomorphy boils distribution down to stem phonotactics. In his account, sound patterns in suffixation are driven by sound patterns in stems. After reviewing the distribution of the allomorphs of the Swedish non-neuter definite article, we will show that the distribution of these allomorphs cannot be reduced to stem phonotactics (as correctly noted in Teleman 1969). Distribution is driven by perceptual salience, and it is generated by constraint rankings projected from the P-map (Steriade 2001). Minimality and sonority sequencing fail to account for the pattern.

1.2 Distribution of allomorphs

Consider the distribution of the allomorphs. After vowels, the allomorph /n/ surfaces[5]:

(18)

SG. = STEM	NON-N. SG. DEF.	*	GLOSS
[byː]	[ˈbyːn]	*[ˈbyːən]	'village'
[frʉː]	[ˈfrʉːn]	*[ˈfrʉːən]	'wife'
[bruː]	[ˈbruːn]	*[ˈbruːən]	'bridge'

The preference of [n] over [ən] post-vocalically is not motivated by phonotactics. The neuter singular definite article has the allomorphs [t] and [ət]. In standard Swedish, the allomorph [ət], not [t][6], surfaces after stressed vowels:

[5] Teleman 1969 mentions some cases where the epenthetic vowel appears after a vowel-final stem (the most famous case being orthographic *akademi-akademien*). However, Riad 2003 convincingly argues that these are mere orthographic artifacts.

(19)

SG. = STEM	N. SG. DEF.	*	GLOSS
[blyː]	[ˈblyːət]	*[blyːt]	'lead'
[kʉː]	[ˈkʉːət]	*[kʉːt]	'letter Q'
[buː]	[ˈbuːət]	*[buːt]	'nest'

The UR /n/ is also suggested by lateral-final trochee stems:[7]

(20)

SG. = STEM	NON-N. SG. DEF.	*	GLOSS
[ˈkɔnsəl]	[ˈkɔnsəln]	*[ˈkɔnsələn]	'consul'
[ˈnʏkːəl]	[ˈnʏkːəln]	*[ˈnʏkːələn]	'key'

We therefore depart from Teleman 1969, Eliasson 1972, and Hellberg 1974, who have assumed /ən/ as the underlying representation. We agree with Linell 1972 and Riad 2003 that /n/ is the UR.

Unsurprisingly, epenthesis applies after stem-final obstruents.

(21)

SG. = STEM	NON-N. SG. DEF.	*	GLOSS
[gruːp]	[ˈgruːpən]	*[ˈgruːpn]	'hole'
[iːs]	[ˈiːsən]	*[ˈiːsn]	'ice'

This is banal, since the clusters obstruent-n would be phonotactically deviant in Swedish, and the language does not feature syllabic nasals.

More interestingly, the allomorph [ən] appears after a stem-final nasal, whether that nasal is short or long.

---

[6] Teleman 1969 uses /e/ where I (following Elert 1997) use /ə/. Teleman lists the /e/ in parenthesis in these forms; in nonstandard dialects, this /e/ can be dropped. In standard Swedish, however, this /e/ is generally not dropped before the neuter article, though there is some lexical variation. See Riad 2003 for discussion.

[7] Two exceptions are [ˈhimːəl] 'heaven', which surfaces as [ˈhimːəln], [ˈhimːlən] or [ˈhimːələn]; and [ˈfjɛːril] 'butterfly' which surfaces as [ˈfjɛːrilən]. However, Riad 2003 notes that the trochee pattern is the default one.

(22)

SG. = STEM	NON-N. SG. DEF.	*	GLOSS
[krɛːm]	[ˈkrɛːmən]	*[krɛːmn]	‘cream’
[rɑːm]	[ˈrɑːmən]	*[rɑːmn]	‘frame’
[rɛ̝mː]	[ˈrɛ̝mːən]	*[rɛ̝mn][8]	‘strap’
[strø̝mː]	[ˈstrø̝mːən]	*[strø̝mn]	‘current’
[rɪŋː]	[ˈrɪŋːən]	*[rɪŋn]	‘ring’

This is no minimality effect: epenthesis applies to polysyllabic nasal-final forms, independent of their stress and morphological structure.

(23)

SG. = STEM	NON-N. SG. DEF.	*	GLOSS
[ˈpɪlgrɪm]	[ˈpɪlgrɪmən]	*[ˈpɪlgrɪmn]	‘pilgrim’
[kɔˈstyːm]	[kɔˈstyːmən]	*[kɔˈstyːmn]	‘outfit’
[ˈvɛ̝lːɪŋ]	[ˈvɛ̝lːɪŋən]	*[ˈvɛ̝lːɪŋn]	‘porridge’
[øŋː + dʊmː]	[øŋːdʊmːən]	*[øŋːdʊmn]	‘young’ + ‘n.-frm.’
[ɔldər + dʊmː]	[ɔldərdʊmːən]	*[ɔldərdʊmn]	‘age’ + ‘n.-frm.’
[ɛ̝lsk + lɪŋ]	[ɛ̝lsk + lɪŋən]	*[ɛ̝lsk + lɪŋn]	‘love’ + ‘dim.’
[rɛ̝dː + nɪŋ]	[rɛ̝dː + nɪŋən]	*[rɛ̝dː + nɪŋn]	‘save’ + ‘n.form.’

This is not due to stem phonotactics (Teleman 1969:196): [mn] and [ŋn] are licit codas in Swedish monomorphemes:

(24)

STEM = SG.	GLOSS
[hʏmn]	‘hymn’
[jɛ̝mn]	‘even’
[hamn]	‘harbor’
[dʏŋn]	‘24 hours’

[8] Long consonants are shortened in preconsonantal position. See Kloster Jensen (1962).

[hɛ̥ŋn]	'protection'
[vaŋn]	'wagon'

The following minimal pairs contrast the grammaticality of tautomorphemic word-final [mn] and [ŋn] with the ungrammaticality of heteromorphemic [m + n] and [ŋ + n]:

(25)	monomorpheme	[sø̥mn]			'sleep'
	but:	[sø̥mː]	→	[ˈsø̥mːən]	'the seam'
				*[sømn]	
	monomorpheme	[sɛ̥ŋn]			'legend'[9]
	but:	[sɛ̥ŋː]	→	[ˈsɛ̥ŋːən]	'the bed'
				*[sɛŋn]	

In stems ending in [l] with final stress, the definite article is [ən]. This applies to monosyllabic stems, polysyllabic stems, and both singleton and geminate [l]:

(26)

STEM	NON-N. SG. DEF.	*	GLOSS
[vɑːl]	[ˈvɑːlən]	*[vɑːln]	'whale'
[kɔrˈprɑːl]	[kɔrˈprɑːlən]	*[kɔrˈprɑːln]	'corporal'
[valː]	[ˈvalːən]	*[valːn]	'rampart'
[məˈtalː]	[məˈtalːən]	*[məˈtaln]	'metal'

Just as epenthesis after nasal-final stems is independent of stem phonotactics, the epenthesis after lateral-final stems is independent of stem phonotactics (Teleman 1969:196). Lateral-n clusters are non-deviant in monomorphemes, as the following lexical item illustrates:

[9] Not all dialects feature this word. The more common unaffixed pronunciation is [sɛːgən]. Both pronunciations are listed in Hedelin 1997.

(27) STEM = SG. GLOSS

[moːln] 'cloud'

The following minimal pair shows conclusively that stem phonotactics cannot capture the allomorphic pattern at hand:

(28)	monomorpheme	[ɑːln]			'ell'
	but:	[ɑːl]	→	[ɑːlən]	'the alder'
				*[ɑːln]	

We have seen, then, that the pattern of [ə]-epenthesis before the /n/ non-neuter definite morpheme is not driven by stem phonotactics.

1.3 Perceptually driven allomorphy

Epenthesis of [ə] before the article /n/ after sonorants [l m ŋ] is driven by perceptual salience. Since /n/ carries the functional load of morpheme, it is under stricter perceptibility requirements than non-morphemic /n/. The epenthesis of [ə] optimizes the distinction between the definite form in the noun's paradigm from the (unaffixed) non-definite form.

Kiparsky (1982:87) notes the functional nature of paradigmatic distinctness:

> [V]arious types of regularities in phonology and morphology ... are based on general conditions of a *functional* nature. [...] We have... *distinctness conditions,* which...state that there is a tendency for semantically relevant information to be retained in surface structure.

In intraparadigmatic homophony, non-distinctness is violated. Crosswhite 1999 formalizes the constraint ANTI-IDENTITY to rule out this state of affairs:

(29) For two forms, S_1 and S_2, where $S_1 \neq S_2$, $\exists\alpha$, $\alpha \in S_1$, such that $\alpha \neq R(\alpha)$

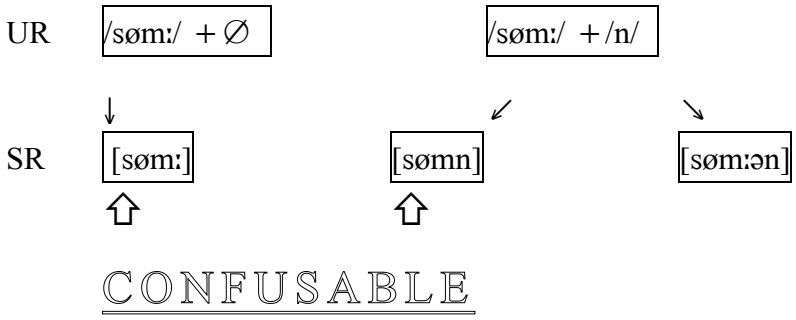
Informally, this constraint states that two tautoparadigmatic forms S_1 and S_2 must be segmentally non-identical.[10] If two tautoparadigmatic forms are homophonous, ambiguity is introduced to the system, such that semantic distinctness is not captured in the phonology. Semantic information is not being retained in an optimal fashion; in this sense, distinctness is violated.

We will borrow Kiparsky's and Crosswhite's plausible intuition regarding the functional significance of paradigmatic distinctiveness. However, we will formalize it in a gradient—not categorical—fashion. For morphophonological exponence to be functionally effective, it must be relatively salient. From a functional perspective, we should expect different members of a paradigm to not only be phonologically distinct; they should be perceptually distinct to a non-trivial degree. An overly subtle perceptual distinction is functionally worthless.

Take the Swedish stem /sø̞mː/ 'seam'. The non-definite form has a null suffix, so it surfaces as [sø̞mː]. The definite form might surface with either [n] or [ən], featuring the epenthetic [ə]. While the former is phonetically distinct from the non-definite form, they are nevertheless somewhat confusable.

[10] For related formalisms, see Alderete 2001, Gnanadesikan 1997, Kurisu 2001, Rose 1997, Samek-Lodovici 1993, and Walker 2000.

(30)



The mechanism that chooses the allomorph with epenthetic [ə] is the mechanism that minimizes confusability within a single stem's paradigm.

Even the most robust phonetic distinction—say [s] versus [a]—can be rendered imperceptible in a sufficiently noisy ambiance: a given morphemic exponence inevitably features some level of perceptual fragility. We posit *NONDIST MORPH as a family of constraints, where any sound/context combination incurs a violation, since any sound/context combination is, to some degree, perceptually fragile:

(31) ***NONDIST MORPH—a constraint family**

For two tautoparadigmatic morphemes M_i and M_j , $i \neq j$, with respective phonetic exponence m_i and m_j , then exponence m_i at context K incurs a violation *NONDIST MORPH (m_i,m_j / K).

Then, following Steriade 2001, the relative fragility of a morpheme in various contexts is projected from the P-map to the constraint ranking. Following Steriade 2001, the default ranking of the various *NONDIST MORPH constraints depends on the relative confusability of the morphemic exponence with other tautoparadigmatic exponences.

(32) **P-map-to-ranking projection of *NONDIST MORPH**

For two contexts K_a and K_b, $a \neq b$,

and two tautoparadigmatic morphemic exponences m_i and m_j , $i \neq j$,

If $\Delta (m_i,m_j) / K_a \quad < \quad \Delta (m_i,m_j) / K_b$,

then *NONDIST MORPH $(m_i,m_j / K_a) \gg$ *NONDIST MORPH $(m_i,m_j / K_b)$.

Consider vowel-final stems and m-final stems as illustrations. First, we will consider the influence of the post-vocalic and post-nasal contexts on the perceptual distinctiveness of the morpheme /n/. Then we will see how this generates a P-map representation, which in turn generates a ranking of OT constraints, which is part of the Swedish grammar.

1.4 Cues for [n]

Three kinds of information must be retrieved for the perception of the segment /n/ to be salient. The listener must retrieve (a) the segmental status of the gesture, (b) the coronal place of articulation, (c) the nasal manner of articulation. Wright 2004 and Raphael 2007 provide overviews of perceptual cues of various sounds, including [n].

To identify segmental status of the gesture, the key is signal modulation, according to Kawasaki 1982 and Ohala 1992. Wright (2004:47) summarizes their proposal, which is

> based on the assumption that change (modulation) along an acoustic dimension, such as frequency or amplitude, will result in increased salience of the cues in the portion of the signal where the change occurs. Therefore, the greater the modulation and the more dimensions that are involved, the better the segmental organisation.

Segmental clusters that provide redundant cues are more robustly encoded than those with fragile cues. The converse also holds (Wright 2004:48):

> [S]equences with a similar degree of aperture (stop + stop, fricative + fricative, nasal + nasal etc.) result in a poor encoding both because they result in very little perceptual benefit from overlap, and because they result in little signal modulation.

Those clusters which lack sufficient signal modulation will be perceptually fragile.

Place cues, according to Wright (2004:37) 'are found in the brief transitional period between a consonant and an adjacent segment....' The crucial information is in the second and third formant, which 'provide the listener with cues to the place of articulation of consonants with oral constrictions....' While the nasal pole-zero pattern includes some information about place, listeners 'identify the place of articulation more reliably from formant transitions than the nasal portion of the signal; therefore the F2 transition is considered the more powerful cue' (Wright 2004:38, citing Malécot 1956). Raphael (2007:196) similarly notes that

> although each nasal [stop] has a distinctive spectrum, the acoustic properties varying with nasal place contrasts are not particularly prominent. This fact, coupled with similarity of the (relatively highly damped) nasal murmur for all the sounds makes it difficult for listeners to distinguish among them. Listeners must therefore rely on the formant transitions into and out of the nasal articulation to aid in identification....

So, a V-C transition optimizes identification of coronal place in a sound such as [n].

As far as manner is concerned, nasalization is cued by '[a] less severe drop in amplitude [compared to fricatives or stops] accompanied by nasal murmur and a nasal pole and zero' (Wright 2004:39; citing Hawkins & Stevens 1985). Some information

preceding the actual murmur is helpful, too: '[n]asalisation of the preceding vowel (weakening of the higher formants, broadening of formant bandwidths, and the introduction of a nasal formant) provides look-ahead cues to the nasal manner' (Wright 2004, 39, citing Ali, Gallager, Goldstein & Daniloff 1971, Hawkins & Stevens, 1985).

So, we have clear notions of why the sound [n] is more salient in post-vocalic position than in post-nasal position; specifically, why the suffix [n] is more salient in the output like [sø̞mːən] than in [sø̞mn]. The vowel and the nasal have different frequencies and amplitudes, providing signal modulation, facilitating segmentation. The vowel-nasal transition (in this case, [ə]-[n]) provides clear formant transitions into the nasal, cueing the coronal place of articulation. The vowel carries some nasalization, helping the listener to identify the nasal manner of articulation. Summarizing: segmental status, place, and manner of [n] are easy to identify in post-vocalic position.

In contrast, the sound [n] after a nasal is highly non-salient. First, the signal modulation between [m] and [n] is minimal, since the sounds are so similar, both in terms of frequency and amplitude. So, segmental parsing is impeded. Second, the [m]-[n] transition in the hypothetical bimorphemic output allomorph [sømn] provides no V-C formant transitions to signal place. Third, the nasalization on the vowel is triggered by the [m], not the suffix, so the informative look-ahead cue of nasalization does not aid in the perception of the suffix. In short, segmental status, place, and manner of [n] are difficult to identify in post-nasal position.

We might summarize these facts in a chart:

(33)

	n/N_#	n/V_#
Signal modulation: spectrum	WEAK CUE	STRONG CUE
Signal modulation: amplitude	NO CUE	STRONG CUE
Place: V-C formant transition	NO CUE	STRONG CUE
Manner:	NO CUE	STRONG CUE
Nasalization on preceding segment, conditioned by /n/		

These facts suggest the following P-map fragment:

(34)

Context Morphemes	N_#	V_#
n/∅	n/∅	n/∅

That is, the morphemes /n/ and ∅ are highly confusable, i.e., perceptually non-distinct in the context N_#. High confusability is represented by means of the small font. The same morphemes /n/ and ∅ are not highly confusable in the context V_#. Low confusability is represented by means of large font.

Recall the principle of constraint projection:

(35) =(32)

P-map-to-ranking projection of *NONDIST MORPH

For two contexts K_a and K_b, $a \neq b$,

and two tautoparadigmatic morphemic exponences m_i and m_j , $i \neq j$,

If $\Delta (m_i,m_j) /K_a < \Delta (m_i,m_j) / K_b$,

then *NONDIST MORPH (m_i,m_j / K_a) ≫ *NONDIST MORPH (m_i,m_j / K_b).

We have here two contexts, N_# and V_#; and we have two morphemes /n/ and ∅. The difference between /n/ and ∅ in context N_# is smaller than their difference in context V_#. This generates, according to the principle of constraint projection, the following ranking:

(36) *NONDIST MORPH (n,∅/N_#) ≫ *NONDIST MORPH (n,∅/V_#)

Epenthesis is driven by a DEP-V constraint, which rules out vowel epenthesis (Prince & Smolensky 1993/2004). This constraint is interleaved between the two relativized *NONDIST MORPH constraints. Since DEP-V is ranked lower than *NONDIST MORPH (n,∅/N_#), epenthesis applies to m-final stems, as the following tableau illustrates:

(37)

	/søm: + n/ 'the seam'	*NONDIST MORPH (n,∅/N_#)	DEP-V	*NONDIST MORPH (n,∅/V_#)
a.	sømn	*!		
b. >	søm:ən		*	*

On the other hand, the epenthetic form is harmonically bounded w.r.t. the non-epenthetic form in the case of vowel-final stems:

(38)

	/by + n/ 'the village'	*NonDist Morph (n,∅/N_#)	Dep-V	*NonDist Morph (n,∅/V_#)
a. >	by:n			*
b.	by:ən		*!	*

For this reason, no epenthesis takes place after vowel-final stems.

The *NonDist Morph constraints only apply to morphemes, not phonemes. It is for this reason that it does not apply the [n] in the monomorpheme /sømn/ 'sleep'. The relevant markedness constraint—call it *Phonotactic (n/N_#) —is ranked sufficiently low in the Swedish grammar, so as to play no role in choosing the winning output.

(39)

	/sømn/ 'sleep'	*NonDist Morph (n,∅/N_#)	Dep-V	*NonDist Morph (n,∅/V_#)	*Phono-tactic (n/N_#)
a. >	sømn				*
b.	søm:ən		*		

1.5 Why no epenthesis after lateral-final[11] stems penultimate stress?

Lateral-final stems behave schizophrenically, sometimes following the epenthesis pattern of nasal-final stems and sometimes following the non-epenthesis pattern of vowel-final stems.

[11] The patterns described apply to r-final stems as well. I set them aside, however, since there is a confound in this case: [r] followed by [n] coalesces into a post-alveolar nasal. This introduces complications beyond the present thesis.

Lateral-final stems with penultimate stress generally do not trigger epenthesis (Riad 2003). Recall the following data:

(40)

SG. = STEM	NON-N. SG. DEF.	*	GLOSS
[ˈsʏkːəl]	[ˈsʏkːəln]	[ˈsʏkːələn]	'bicycle'
[ˈfoːgəl]	[ˈfoːgəln]	[ˈfoːgələn]	'bird'
[ˈkɔnsəl]	[ˈkɔnsəln]	[ˈkɔnsələn]	'consul'

This is reminiscent of vowel-final stems with penultimate stress, which also do not trigger epenthesis:

(41)

SG. = STEM	NON-N. SG. DEF.	*	GLOSS
[ˈblʊmːa]	[ˈblʊmːan]	*[ˈblʊmːaən]	'flower'
[ˈtɔdːʏ]	[ˈtɔdːʏn]	*[ˈtɔdːʏən]	'toddy'

Nasal-final words with penultimate stress, in contrast, do trigger epenthesis:

(42)

STEM	NON-N. SG. DEF.	*	GLOSS
[ˈpɪlgrim]	[ˈpɪlgrɪmən]	*[ˈpɪlgrɪmn]	'pilgrim'
[ˈçʏkːlɪŋ]	[ˈçʏkːlɪŋən]	*[ˈçʏkːlɪŋn]	'chicken'

In short, when a stem has penultimate stress, lateral-final stems pattern like vowel-final stems, not like nasal-final ones.

Lateral-final stems with final stress, however, pattern like nasal-final stems, and unlike vowel-final stems. Stems of this structure always license epenthesis before the article. The following list features monosyllabic stems ending in either singleton /l/ or geminate /lː/.

(43)

STEM	NON-N. SG. DEF.	*	GLOSS
[piːl]	[ˈpiːlən]	*[piːln]	'arrow'
[vɑːl]	[ˈvɑːlən]	*[vɑːln]	'whale'
[grɪlː]	[ˈgrɪlːən]	*[grɪln]	'barbecue'
[valː]	[ˈvalːən]	*[valn]	'rampart'

The following list features the same pattern in polysyllabic stems stressed on the final syllable:

(44)

STEM	NON-N. SG. DEF.	*	GLOSS
[mʊˈrɑːl]	[mʊˈrɑːlən]	*[mʊˈrɑːln]	'moral'
[pɪˈstuːl]	[pɪˈstuːlən]	*[pɪˈstuːln]	'pistol'
[məˈtalː]	[məˈtalːən]	*[məˈtaln]	'metal'
[paˈtrəlː]	[paˈtrəlːən]	*[paˈtrəln]	'patrol'

This pattern of epenthesis is reminiscent of epenthesis after nasal-final stems, which always license epenthesis:

(45)

STEM	NON-N. SG. DEF.	*	GLOSS
[sø̞mː]	[ˈsø̞mːən]	*[sø̞mn]	'seam'
[maˈdamː]	[maˈdamːən]	*[maˈdamn]	'madame'
[sɛ̞ŋː]	[ˈsɛ̞ŋːən]	*[sɛ̞ŋn]	'bed'
[maˈrɛ̞ŋː]	[maˈrɛ̞ŋːən]	*[maˈrɛŋːn]	'meringue'

This contrasts with vowel-final words with final stress, which generally do not license epenthesis:[12]

[12] As noted, a few lexical exceptions exist. See Teleman 1969 for discussion.

(46)	SG. = STEM	NON-N. SG. DEF.	*	GLOSS
	[byː]	[ˈbyːn]	*[ˈbyːən]	‘village’
	[əsɛː]	[əˈsɛːn]	*[əˈsɛːən]	‘essay’
	[aˈleː]	[aˈleːn]	*[aˈleːən]	‘avenue’

Summarizing, lateral-final stems pattern like vowel-final stems when they have penultimate stress, but they pattern like nasal-final stems when they have final stress.

Lateral-final stems pattern like something intermediate between nasal-final stems and vowel-final stems precisely because the perceptibility of [n] in post-lateral position before a word-boundary—in a context we might call ‘L_#’—is intermediate between the perceptibility of [n] in contexts N_# and V_#.

Let us return to Wright’s observations about the cues that render the sound [n] salient. A preceding [l], being coronal, will not provide transitional place information about a following coronal, since no place transition takes place. For this reason, a transition [l]-[n] will not provide good cues to identify the coronal place of articulation of the nasal.

To facilitate segmentation, Wright refers to signal modulation, both in terms of frequency and amplitude. In his discussion of acoustic analysis of sounds, Ladefoged (2000:182) notes that the amplitude correlates of nasals and laterals are similar: ‘A clear mark of a nasal (or...a lateral) consonant is an abrupt change [i.e., reduction in intensity] in the spectrogram at the time of the formation of the articulatory closure....’ The frequencies of nasals and laterals are distinct, however: nasals have ‘nasal formants at about 250, 2,500, and 3250 Hz’ whereas laterals have ‘formants in the neighborhood of 250, 1200 and 2400 Hz’ with ‘[t]he higher formants...considerably reduced in intensity’ (Ladefoged 2000:185). Both nasals and laterals feature formants around 250 and 2400-2500; the crucial difference is that laterals feature resonances at 1200, unlike nasals.

Summarizing, nasals and laterals have a similar amplitude but vary somewhat in their spectra. Amplitude modulation is presumably a poor cue, while spectrum modulation may facilitate segmentation somewhat.

Wright observes that anticipatory nasalization on the segment before /n/ cues the nasal feature. Since the lateral can carry this anticipatory nasalization, nasal manner will be cued to some extent, though presumably not to the extent that it is cued in post-vocalic position.

We might summarize these findings, and incorporate them with our previous findings regarding cues for [n] in contexts N_# and V_#.

(47)

	n/N_#	n/L_#	n/V_#
Signal modulation: spectrum	WEAK CUE	WEAK CUE	STRONG CUE
Signal modulation: amplitude	NO CUE	MED CUE	STRONG CUE
Place: V-C formant transition	NO CUE	WEAK CUE	STRONG CUE
Manner: Nasalization on preceding segment, conditioned by /n/	NO CUE	MEDIUM CUE	STRONG CUE

The intermediate status of cue-strength of [n] in context L_# compared to contexts N_# and V_# implies an intermediate status of confusability of distinct tautoparadigmatic morphemic exponences [n] and ∅. The following P-map fragment captures this:[13]

(48)

Context / Morphemes	N_#	L_#	V_#
n/∅	n/∅	n/∅	n/∅

[13] The P-map is verified experimentally in sections 6.2 and 6.3.

Following the schema above, the P-map in (52) generates the following OT rankings:

(49) *NONDIST MORPH (n,∅/N_#)

≫ *NONDIST MORPH (n,∅/L_#)

≫ *NONDIST MORPH (n,∅/V_#)

The epenthesis of [ə] after lateral-final stressed syllables suggests the following ranking:

(50) *NONDIST MORPH (n,∅/N_#)

≫ *NONDIST MORPH (n,∅/L_#)

≫ DEP-V, *NONDIST MORPH (n,∅/V_#)

This generates an output with epenthetic [ə].

(51)

/ˈɑːl + n/ 'the alder'	*NONDIST MORPH (n,∅/N_#)	*NONDIST MORPH (n,∅/L_#)	DEP-V	*NONDIST MORPH (n,∅/V_#)
a. ˈɑːln		*!		
b. > ˈɑːlən			*	*

However, this ordering generates the incorrect output for l-final trochee stems:

(52)

/ˈkɔnsəl + n/ 'the consul'	*NONDIST MORPH (n,∅/N_#)	*NONDIST MORPH (n,∅/L_#)	DEP-V	*NONDIST MORPH (n,∅/V_#)
a. ˈkɔnsəln		*!		
b. 💣 ˈkɔnsələn			*	*

It appears that some additional constraint is active, which disfavors candidate (b). If this constraint—call it C—were ranked above *NONDIST MORPH (n,∅/L_#), the correct output would be generated.

(53)

	/ˈkɔnsəl + n/ 'the consul'	*NONDIST MORPH (n,∅/N_#)	C	*NONDIST MORPH (n,∅/L_#)	DEP-V	*NONDIST MORPH (n,∅/V_#)
a. >	ˈkɔnsəln			*		
b.	ˈkɔnsələn		*!		*	*

The nature of this constraint C is the next topic to address.

1.6 A prosodic constraint

Prosodically, candidate (b) in tableau (63) is a dactyl—the pattern ˈσ σ σ—and the canonical foot in Swedish is a bisyllabic trochee (ˈσ σ) (Riad 1992, 2002, 2003). The influence of prosodic structure in syncope is familiar, and the preference for trochaic feet is well attested in the Germanic languages.

The marked status of the dactyl is noted in morphologically driven syncope[14]

(54)

STEM	PL. AFFIX	CORRECT	*	GLOSS
[mɔrgɔn]	[ar]	[ˈmɔrgnar]	*[ˈmɔrgɔnar]	'morning'

Assume that dactyls involve an unparsed final syllable, with only the first two syllables footed: (ˈσ σ) σ. Then we can naturally derive the non-optimality of candidate (b) from a constraint against unfooted syllables:

(55) PARSE-σ All syllables must be footed.

[14] See Eliasson 1972 and Riad 2003 for discussion.

This is the constraint alluded to above—constraint C—which disprefers the candidate [ˈkɔnsələn], leaving [ˈkɔnsəln] to be the optimal candidate:[15]

(56)

/ˈkɔnsəl + n/ 'the consul'	*NONDIST MORPH (n,∅/N_#)	PARSE-σ	*NONDIST MORPH (n,∅/L_#)	DEP-V	*NONDIST MORPH (n,∅/V_#)
a. > (ˈkɔnsəln)			*		
b. (ˈkɔnsəl)ən		*!		*	*

PARSE-σ must be ranked lower than *NONDIST MORPH (n,∅/N_#), in order to generate dactyl outputs when the non-neuter article associates with a m-final trochee stem:

(57)

/ˈpɪlgrɪm + n/ 'the pilgrim'	*NONDIST MORPH (n,∅/N_#)	PARSE-σ	*NONDIST MORPH (n,∅/L_#)	DEP-V	*NONDIST MORPH (n,∅/V_#)
a. (ˈpɪlgrɪmn)	*!				
b. > (ˈpɪlgrɪm)ən		*		*	*

1.7 Alternative accounts

Before setting forth our perceptual account of allomorphy, we showed the inappropriateness of an approach that relied on stem phonotactics. Minimality and sonority sequencing are equally inappropriate as accounts of the present allomorphy.

[15] Also the candidate [ˈkɔnslən], where the stem vowel is deleted, must be ruled out. This would satisfy both PARSE-σ and *NONDIST MORPH (n/L_#). While the plural morpheme triggers syncope in the stem, the non-neuter definite article does not. For example, the definite singular [morgonen] is dactylic, while the plural [ˈmorgnar] is trochaic, due to syncope. A given stem-internal vowel features different levels of robustness depending on the suffix (Eliasson 1972); this merits investigation.

Given that [ə]-epenthesis inevitably adds prosodic material—it adds a syllable to the stem—one might suggest that epenthesis is driven by minimality. This is not the case, however, since the default foot in Swedish is trochaic (Löfstedt 1992, Riad 1992, 2002, 2003), but the [ə]-epenthesis occurs after nasal-final trochees, thereby creating dactyls.

(58)

STEM	NON-N. SG. DEF.	GLOSS
[ˈmeːdləm]	[ˈmeːdləmən]	'member'
[ˈvɛ̝lːɪŋ]	[ˈvɛ̝lːɪŋən]	'porridge'

Clearly, then, minimality cannot be the driving force behind the licensing of epenthesis after nasal-final trochee, since the resulting forms are dactyls.

Furthermore, if minimality were a condition on derived forms, we would expect all polymorphemic forms to be at least trochaic. This is not the case, as we can see by looking at suffixes such as the neuter /t/, participle /d/, and supine /t/. These suffixes associate with CVC stems, resulting in monosyllabic CVC + C forms.

(59)

	STEM	CORRECT	*	GLOSS
PARTICIPLE	[dø̞mː]	[dø̞md]	*[dø̞mːəd]	'judge'
SUPINE	[dø̞mː]	[dø̞mt]	*[dø̞mːət]	'judge'
NEUTER	[lɑːm]	[lɑːmt]	*[lɑːmət]	'lame'

So, minimality fails to account for the epenthesis of [ə] in Swedish allomorphy, since epenthesis overapplies (creating dactyls) in nasal-final trochee stems, and since epenthesis underapplies (failing to create trochees) in monosyllabic polymorphs featuring the participle, supine, and neuter suffixes.

One might wish to argue that the epenthesis after lateral-final stems and nasal-final stems is driven by sonority sequencing. No doubt, the nasal suffix /n/ is close to the lateral and nasals in terms of the sonority scale. If there were some minimum

sonority distance that applied in complex codas, perhaps this could explain the vowel-epenthesis.

This approach cannot work, however. If we consider the participle, supine, and neuter suffixes, we note that zero sonority distances are grammatical in complex codas. The participle suffix is /d/, and it is grammatical after another voiced stop, e.g., /g/:

(60)

	STEM	CORRECT	*	GLOSS
PARTICIPLE	[tɪgː]	[tɪgd]	*[tɪgːəd]	'beg'

Similarly, the supine and neuter suffixes are /t/, and they appear without epenthesis after other voiceless stops, e.g., /k/:

(61)

	STEM	CORRECT	*	GLOSS
SUPINE	[slɛ̝kː]	[slɛ̝kt]	*[slɛ̝kːət]	'extinguish'
NEUTER	[çɛ̝kː]	[çɛ̝kt]	*[çɛ̝kːət]	'smart, stylish'

So there is no reason to assume that a minimum sonority distance is driving the epenthesis in the non-neuter definite suffix.[16]

1.8 *NonDist Morph and Evolutionary Phonology

The present study relies explicitly on the inherent perceptual properties of sounds in given contexts. As such, it is at odds with the central tenet of Evolutionary Phonology (henceforth, EP; Blevins 2004), according to which sound patterns are mere artifacts of transmission of language from one generation to the next.

The proposal makes crucial reference to the P-map, which drives the epenthesis pattern in the paradigm of the Swedish non-neuter singular definite suffix. The following relative rankings were shown to be crucial:

[16] It might also be noted that the antigemination account of Bakovic 2005 is irrelevant to Swedish: adjacent nasals do not geminate, and geminate nasals are not ungrammatical.

(62) = (49) *NONDIST MORPH (n,∅/N_#)

≫ *NONDIST MORPH (n,∅/L_#)

≫ *NONDIST MORPH (n,∅/V_#)

This relative ranking was projected from the following P-map fragment:

(63) = (48)

Context Morphemes	N_#	L_#	V_#
n/∅	n/∅	n/∅	n/∅

Reference to the primary content of the sounds is essential here—the relative confusability between [n] and ∅ in various segmental contexts drives the present analysis. If the classes 'nasals', 'laterals', and 'vowels' were simply handy expositional devices, unmotivated by actual phonetic properties, then the present proposal would be stipulative, descriptive, and of no interest. In short, there would be no account of the epenthesis pattern in Swedish.

Blevins (2004:27) claims that

> [t]here is no need to encode the primary content of phonological representations and constraint systems in the human mind, since these properties can be shown to emerge from natural processes of language change inherent to the transmission of language from one generation to the next.

According to EP, the pattern of the Swedish non-neuter definite article is simply a historical artifact. Assuming that it was historically /ən/, the schwaless allomorphs must be accounted for by crossgenerational transmission. The vowel has been lost post-

vocalically and occasionally post-laterally: it must be shown that the sound is fragile in these contexts. The schwa has been deleted post-vocalically before the non-neuter [n].

(64)

SG. = STEM	NON-N. SG. DEF.	GLOSS
[byː]	[ˈbyːn]	'village'
[frʉː]	[ˈfrʉːn]	'wife'
[bruː]	[ˈbruːn]	'bridge'

Recall, in contrast, that hiatus remains with the neuter definite article:

(65)

SG. = STEM	N. SG. DEF.	GLOSS
[blyː]	[ˈblyːət]	'lead'
[kʉː]	[ˈkʉːət]	'letter Q'
[buː]	[ˈbuːət]	'nest'

EP would explain the contemporary schwa-less pattern in context V_n if schwa is harder to perceive in the context V_n than in the context V_t.

The deletion of schwa after l-final trochees similarly predicts that the schwa in that position is difficult to perceive.

(66)

SG. = STEM	NON-N. SG. DEF.	*	GLOSS
[ˈkɔnsəl]	[ˈkɔnsəln]	*[ˈkɔnsələn]	'consul'
[ˈnʏkːəl]	[ˈnʏkːəln]	*[ˈnʏkːələn]	'key'

In particular, it is more difficult to perceive than a schwa after a nasal-final trochee, where the schwa has not been deleted:

(67)

STEM	NON-N. SG. DEF.	*	GLOSS
[ˈmeːdləm]	[ˈmeːdləmən]	*[ˈmeːdləmn]	'member'
[ˈvɛ̝lːɪŋ]	[ˈvɛ̝lːɪŋən]	*[ˈvɛ̝lːɪŋn]	'porridge'

Establishing these relative scales of perceptibility of schwa lies beyond the scope of the present study.

1.9 Local summary

We have seen that the constraint family *NONDIST MORPH, projected into the phonological constraint system from relative rankings in the P-map, accounts for the allomorphy of the Swedish singular non-neuter definite suffix. The P-map, together with a principle of projection into the phonology, provides the following ranking:

(68) =(49) *NONDIST MORPH (n,∅/N_#)

≫ *NONDIST MORPH (n,∅/L_#)

≫ *NONDIST MORPH (n,∅/V_#)

Interleaved among these constraints are PARSE-σ, which penalizes unfooted syllables; and DEP-V, which penalizes epenthetic vowels.

(69) *NONDIST MORPH (n,∅/N_#)

≫ PARSE-σ

≫ *NONDIST MORPH (n,∅/L_#)

≫ DEP-V, *NONDIST MORPH (n,∅/V_#)

This ranking generates the patterns appropriately, and the empirical success of our constraint family *NONDIST MORPH lends credence to our thesis of perceptually driven allomorphy.

2 n-final stems and *REPETITION

2.1 Introduction

In our discussion of the non-neuter singular definite morpheme /n/, the criteria for perceptual salience have been the contextual phonetic cues. When we look at the allomorphy of the non-neuter definite article for stems ending in the coronal nasal /n/, we see that mere contextual cues predict across-the-board licensing of the allomorph /ən/, just as we saw in the case of words ending in non-coronal nasals. The occurrence of morphological haplology in trochee stems ending in /ən/ and /an/ will lead to an expansion of perception-driven grammar to include the effects of repetition blindness.

2.2 n-final stems stressed on the final syllable

The n-final stems ending in a stressed syllable license the allomorph /ən/ for the definite article:

(70)

STEM	DEFINITE	GLOSS
[steːn]	[ˈsteːnən]	'rock'
[løːn]	[ˈløːnən]	'salary'
[soːn]	[ˈsoːnən]	'son'
[grɑːn]	[ˈgrɑːnən]	'pine'

The following list shows the same phenomenon with polysyllabic stems stressed on the final syllable:

(71)

STEM	DEFINITE	GLOSS
[raˈviːn]	[raˈviːnən]	'ravine'
[kapˈteːn]	[kapˈteːnən]	'captain'
[baˈruːn]	[baˈruːnən]	'baron'

As noted in Chapter 1, the epenthesis of [ə] not driven by a ban on geminate nasals. Geminate consonants are ubiquitous in Swedish, including geminate /nː/. Consider these examples:

(72)

STEM	GLOSS
[tɛ̞nː]	'pewter'
[ɧɪnː]	'skin'
[çɛ̞nː]	'feel'
[lø̞nː]	'maple'
[rø̞nː]	'mountain ash'
[tənː]	'thin'
[brənː]	'well (for water)'
[spanː]	'pale'
[ɡranː]	'pretty'

In fact, some of the words on this list are non-neuter noun stems, and they trigger the /ən/ allomorph, just like stems ending in non-geminate /n/:

(73)

STEM	DEFINITE	GLOSS
[lø̞nː]	[lø̞nːən]	'maple'
[rø̞nː]	[rø̞nːən]	'mountain ash'
[brənː]	[brənːən]	'well (for water)'
[spanː]	[spanːən]	'pale'

In short, an n-final stem ending in a stressed syllable triggers epenthesis, just as other nasal-final stems do.

The epenthesis after n-final stems is licensed by the fact that the resulting context for the morphemic exponence [n] is rendered more distinct from the

tautoparadigmatic ∅, in terms of place, manner, and segmental status. The summary of the cues are summarized in the following chart:

(74)

	n/n_#	n/V_#
Signal modulation: spectrum	NO CUE	STRONG CUE
Signal modulation: amplitude	NO CUE	STRONG CUE
Place: V-C formant transition	NO CUE	STRONG CUE
Manner:	NO CUE	STRONG CUE
Nasalization on preceding segment, conditioned by /n/		

The weakness of the cues of [n] in context n_#, contrasted with the strength of the cues of [n] in context V_# , renders [n] and ∅ confusable in the former context, but not so in the latter context. This is summarized in the following P-map fragment:

(75)

Context / Morphemes	n_#	V_#
n/∅	n/∅	**n/∅**

By the mechanism discussed in the Chapter 1, this projects the following constraint ranking:

(76) *NONDIST MORPH (n,∅/n_#)

≫ *NONDIST MORPH (n,∅/V_#)

Recall that epenthesis of [ə] in stems ending in [m] resulted from a nested constraint ranking, with DEP-V interleaved between *NONDIST MORPH (n,∅/n_#) and

*NONDIST MORPH (n,∅/V_#). The same schema generates the epenthetic output for n-final stems stressed on the final syllable.

(77)

	/løn: + n/ 'the maple'	*NONDIST MORPH n,∅/n_#	DEP-V	*NONDIST MORPH n,∅/V_#
a.	løn:n	*!		
b. >	løn:ən		*	*

Setting aside the fact that candidate (a) constitutes an OCP violation—a point orthogonal to the present thesis—it is ruled out by the *NONDIST MORPH (n,∅/n_#) constraint.

Now consider n-final stems that are unstressed on the final syllable.

2.3 n-final stems with penultimate stress

When an n-final stems ends in an unstressed syllable, the definite form may be haplological, with no morphemic exponence for the non-neuter definite article (Teleman 1969, Eliasson 1972, and Hellberg 1974). The following shows stems with penultimate stress, ending in [ən][17]:

[17] Teleman 1969 notes some exceptions: [øːkən] 'desert', [sʊkːən] 'parish', [sɛːgən] 'legend', and [bɔtːən] 'bottom'; these have the definite forms [øːknən], [sʊknən], [sɛːŋnən], and (in some dialects) [bɔtnən]. The last item is often heard in the haplological form; I believe haplology is obligatory in the idiom *Det var botten* 'That was the pits; That was a drag'.

(78)

STEM	DEFINITE	GLOSS
[ˈfrøːkən]	[ˈfrøːkən]	‘unmarried woman, miss’
[ˈkəlmən]	[ˈkəlmən]	‘culmination’
[ˈɔrdən]	[ˈɔrdən]	‘order’
[ˈbɔrjən]	[ˈbɔrjən]	‘surety’
[ˈløːsən]	[ˈløːsən]	‘stamp duty’
[ˈmʏrtən]	[ˈmʏrtən]	‘myrtle’

The following shows the same pattern for words ending in [an]:

(79)

STEM	DEFINITE	GLOSS
[ˈjɪslan]	[ˈjɪslan]	‘hostage’
[ˈbø̞rjan]	[ˈbø̞rjan]	‘beginning’
[ˈfrəktan]	[ˈfrəktan]	‘fear’
[ˈlɛ̞ŋtan]	[ˈlɛ̞ŋtan]	‘longing’
[ˈstrɛːvan]	[ˈstrɛːvan]	‘striving’
[ˈtveːkan]	[ˈtveːkan]	‘doubt’
[ˈtɛːvlan]	[ˈtɛːvlan]	‘contest’
[ˈəndran]	[ˈəndran]	‘wonderment’
[ˈvɛːgran]	[ˈvɛːgran]	‘refusal’
[ˈvɛntan]	[ˈvɛntan]	‘expectation’
[ˈɛ̞ŋslan]	[ˈɛ̞ŋslan]	‘anguish’
[ˈø̞nskan]	[ˈø̞nskan]	‘wish’

The same pattern is seen in words that are prosodically compound, with a stressed prefix:

(80)

STEM	DEFINITE	GLOSS
[ˈanˌmɛːlan]	[ˈanˌmɛːlan]	‘notification’
[ˈanˌsøːkan]	[ˈanˌsøːkan]	‘application’
[ˈanˌtyːdan]	[ˈanˌtyːdan]	‘hint’
[ˈinˌbjʉːdan]	[ˈinˌbjʉːdan]	‘invitation’

Also, words with an unstressed pretonic syllable follow this pattern:

(81)

STEM	DEFINITE	GLOSS
[bəˈjɛːran]	[bəˈjɛːran]	‘request’
[fø̞rˈtviːvlan]	[fø̞rˈtviːvlan]	‘desperation’
[əkˈsɑːmən]	[əkˈsɑːmən]	‘degree’
[ləˈkɑːmən]	[ləˈkɑːmən]	‘body’
[tənˈtɑːmən]	[tənˈtɑːmən]	‘examination’

Notice that this pattern is different from m-final and ŋ-final trochee stems. Stems of the latter type license the /ən/ allomorph, which—recall—result in dactylic SRs:

(82)

STEM	*	DEFINITE	GLOSS
[ˈpɪlgrɪm]	*[ˈpɪlgrɪmn]	[ˈpɪlgrɪmən]	‘pilgrim’
[ˈmeːdləm]	*[ˈmeːdləmn]	[ˈmeːdləmən]	‘member’
[ˈvɛlːɪŋ]	*[ˈvɛlːɪŋn]	[ˈvɛlːɪŋən]	‘porridge’
[ˈçʏkːlɪŋ]	*[ˈçʏkːlɪŋn]	[ˈçʏkːlɪŋən]	‘chicken’

The constraints we have posited so far fail to generate the correct output. Let us see why.

Consider the *NONDIST MORPH violation of the haplological output. Since the phonetic reflex is in fact ∅, it must be ranked higher than other *NONDIST MORPH constraints, since ∅ is infinitely confusable with itself in the P-map in any arbitrary context K:

(83)

Context Morphemes	K
∅/∅	∅/∅

So, we have the relative rankings:

(84) *NONDIST MORPH (∅)

≫ *NONDIST MORPH (n,∅/n_#)

≫ *NONDIST MORPH (n,∅/V_#)

In addition, we will refer to a phonotactic constraint, relevant to the fully faithful candidate:

(85) *X:/ [-stress] No long segments in unstressed syllables.

Consider the tableau, with three crucial candidates: one with a lengthened nasal, one with the [ən] suffix, and one haplological output.

(86)

	/myrten + n/ 'the myrtle'	*X:/ [-STRESS]	*NONDIST MORPH (∅)	*NONDIST MORPH (n,∅/n_#)	DEP-V	*NONDIST MORPH (n,∅/V_#)
a.	ˈmyrtenː	*!		*		
b. 💣	ˈmyrtenen				*	*
c.	ˈmyrten		*			

While candidate (a) is appropriately ruled out by virtue of *X:/-stress, the constraints incorrectly select the dactylic output as the optimal candidate. The incorrectly selected candidate is marked with the bomb symbol.

As an additional complication, stems ending in [ɔn] do create dactyls:

(87)

STEM	DEFINITE	GLOSS
[ˈmɔrgɔn]	[ˈmɔrgɔnən]	'morning'
[ˈaftɔn]	[ˈaftɔnən]	'evening'

The sound pair [ən-ən] triggers haplology as a repetition effect. While [an-ən] also triggers this repetition effect, the sound [ɔn] is sufficiently different from [ən] to be immune to this repetition effect.

2.4 Repetition effects

A repeated stimulus is more difficult to perceive than a novel stimulus. The avoidance of repetition has been attested both in linguistic domains and extralinguistic domains. Stemberger (1981) provides numerous examples of morphological haplology, which he boils down to the avoidance of repetition. Walter 2007 provides an overview of repetition effects. She draws our attention to the following work, among others: Kanwisher (1987) refers to 'repetition blindness', the failure to detect repeated words in visual and aural tests. The phenomenon also applies to extralinguistic tasks such as identifying letters (Park and Kanwisher 1994), numbers (Bavelier and Potter 1992), color patches (Kanwisher et al 1995), relative spatial locations (Epstein and Kanwisher 1999), pictures (Bavelier 1994), images of the same object from different angles and different types within a category (Kanwisher, Yin, and Wojciulik 1997), and orthographically distinct homophonones (Bavelier 1994), among other domains.[18]

Consider a stimulus such as *[ˈmʏrtənən] from the perspective of repetition blindness. Just as a repeated visual stimuli results in poor detection, the repeated

[18] I am grateful to Colin Wilson and MaryAnn Walter for drawing my attention to this phenomenon and these references.

auditory sequence [ən] will be poorly perceived. To some extent, *[ˈmʏrtənən] will simply be sound like [ˈmʏrtən]. In contrast, a stimulus such as [ˈmɔrgɔnən] will not be perceived as [ˈmɔrgɔn], since no strings are being repeated in the stimulus, so repetition blindness has no effect on the word.

Let us formalize this phenomenon of repetition blindness, as it occurs in the n-final trochees of Swedish. Keep in mind the general pattern:

(88)

	STEM	NON-N SG. DEFINITE	NOTE
[ən]-final trochee	[ˈmʏrtən]	[ˈmʏrtən]	*haplology*
[an]-final trochee	[ˈjɪslan]	[ˈjɪslan]	*haplology*
[ɔn]-final trochee	[ˈmɔrgɔn]	[ˈmɔrgɔnən]	*overt sfx*

The epenthetic vowel plus the definite suffix produces the cluster [ən]. The sequences [ən], [an], and [ɔn] have varying degrees of confusability w.r.t. the sequence [ən]. The cluster [ən] is, obviously, infinitely confusable with itself. The cluster [an] is somewhat confusable with [ən], and the cluster [ɔn] is less confusable with [ən].[19] We have the following scale:

(89) Δ (ɔn, ən)

> Δ (an, ən)

> Δ (ən, ən)

If we assume, in a functionalist spirit, that the grammar will treat phonetically salient outputs as preferable to phonetically non-salient outputs, it is reasonable to assume that the grammar will penalize sequences that are overly similar. If a phoneme sequence is likely to trigger the effect of repetition blindness, it is penalized by the grammar. If a phoneme sequence is only somewhat likely to trigger repetition blindness, it is

[19] Establishing this is the topic of two experiments in Chapter 6. See 6.4, 6.5, 6.6 and 6.7.

penalized, but not as severely. If a phoneme sequence is unlikely to trigger repetition blindness, it is penalized even less severely.

All sequences violate *REPETITION, since any phoneme sequence is similar to some extent to any other phoneme sequence:

(90) ***REPETITION—a constraint family**

Any phoneme sequence $<SEQ_I>$ followed by a disjoint adjacent sequence $<SEQ_J>$ incurs a violation *REPETITION (SEQ_I SEQ_J).

The grammar can compare the degree of similarity between pairs of adjacent phoneme sequences. If sequence pairs are very similar, the ranking of the *REPETITION constraint is high. If sequence pairs are less similar, the ranking of the *REPETITION constraint is lower. The is done by projection of *REPETITION constraints:

(91) **P-map-to-ranking projection of *REPETITION**

For pairs of phoneme sequences $<SEQ_I SEQ_J>$ and $<SEQ_K SEQ_L>$,

if Δ (SEQ_I/SEQ_J) > Δ(SEQ_K/SEQ_L),

then *REPETITION (SEQ_K-SEQ_L) $\gg$ *REPETITION (SEQ_I-SEQ_J)

Recall the relative rankings we assumed above:

(92) =(89) Δ (ɔn, ən)

> Δ (an, ən)

> Δ (ən, ən)

By virtue of projection of *REPETITION constraints, the grammar generates the following relative rankings:

(93) *REPETITION (ən-ən)

≫ *REPETITION (an-ən)

≫ *REPETITION (ɔn-ən)

The haplology effect is obtained by interleaving the *NONDIST MORPH (∅) between *REPETITION (an-ən) and *REPETITION (ɔn-ən):

(94) *REPETITION (ən-ən)

≫ *REPETITION (an-ən)

≫ *NONDIST MORPH (∅)

≫ *REPETITION (ɔn-ən)

This means that the phonotactic outputs [ənən] and [anən] are worse than haplological outputs. So, the rankings generate the haplological outputs for [mʏrtən] 'myrtle, def sg.':

(95)

	/mʏrtən + n/ 'the myrtle'	*X:/-STRESS	*REP(ən-ən)	*REP (an-ən)	*NONDIST MORPH (∅)	*REP (ɔn-ən)	*NONDIST MORPH (n,∅/n_#)	DEP-V	*NONDIST MORPH (n,∅/V_#)
a.	ˈmʏrtənː	*!					*		
b.	ˈmʏrtənən		*!					*	*
c. >	ˈmʏrtən				*				

By the same token, the rankings generate the haplological outputs for [jɪslan] 'hostage, def sg':

(96)

/jɪslan + n/ 'the hostage'	*X:/-STRESS	*REP (ən-ən)	*REP (an-ən)	*NONDIST MORPH (∅)	*REP (ɔn-ən)	*NONDIST MORPH (n,∅/n_#)	DEP-V	*NONDIST MORPH (n,∅/V_#)
a. ˈjɪslan:	*!					*		
b. ˈjɪslanən			*!				*	*
c. > ˈjɪslan				*				

For the item [mɔrgɔn + n], however, the ranking *NONDIST MORPH (∅) ≫ *REPETITION (ɔn-ən) ensures that the haplological output is dispreferred.

(97)

/mɔrgɔn + n/ 'the morning'	*X:/-STRESS	*REP (ən-ən)	*REP (an-ən)	*NONDIST MORPH (∅)	*REP (ɔn-ən)	*NONDIST MORPH (n,∅/n_#)	DEP-V	*NONDIST MORPH (n,∅/V_#)
a. ˈmɔrgɔn:	*!					*		
b. > ˈmɔrgɔnən					*		*	*
c. ˈmɔrgɔn				*!				

2.5 Local summary

We have seen that the family of constraints *REPETITION, projected into the phonological constraint system from relative rankings in the P-map, accounts for the allomorphy of the Swedish singular non-neuter definite suffix. The P-map, together with a principle of projection into the phonology, provides the following ranking:

(98) =(93) *REPETITION (ən-ən)

≫ *REPETITION (an-ən)

≫ *REPETITION (ɔn-ən)

Interleaved among these constraints *NonDist Morph (∅), which penalizes null morphemic exponence.

(99) =(94) *REPETITION (ən-ən)

≫ *REPETITION (an-ən)

≫ *NONDIST MORPH (∅)

≫ *REPETITION (ɔn-ən)

This ranking generates the patterns appropriately, and the empirical success of our family of constraints *REPETITION lends credence to our thesis of perceptually driven allomorphy.

3 'Dental gemination' and IDENT [Long C]/K

3.1 Introduction

Swedish morphophonology features verbal and adjectival suffixes which sometimes surface as geminates, and sometimes as singleton consonants. The distribution suffixes may be insightfully formalized by means of ranked constraints projected from the P-map. The suffixes' degemination depends on the salience of the long/short distinction in a given phonetic context. The phenomenon provides a rare example of outside-in allomorphy: the form of the suffix determines the allomorphy of the stem (in particular, the geminate suffix can cause the stem's vowel to surface as short rather than long).

Before looking at the relevant suffixes, a terminological point is in order. The relevant pattern is generally referred to in the literature as 'dental gemination' (Eliasson 1972, Hellberg 1974, Raffelsiefen 2002). The name is of course ontologically loaded. It is generally assumed in the Scandinavian phonological literature that the relevant suffixes are short in UR, and lengthened by rule. In what follows, I will use the term 'dental gemination' simply to refer to the pattern in the data, with no ontological commitment of a gemination process in the phonology. In fact, I will follow the observation of Teleman 1969, who shows that this pattern is one of *de*-gemination; furthermore, it is not limited to dentals.

3.2 The paradigms

Consider the basic facts. In the conjugation with no intervening vowel before the participial, supine, and preterite suffixes, the suffixes on C_0VC verbs are /d/, /t/ and /də/, respectively.

(100)

STEM	PARTICIPLE	SUPINE	PRETERITE	GLOSS
[vɛːg]	[vɛːgd]	[vɛːgt]	[ˈvɛːgdə]	‘weigh’
[ɛːg]	[ɛːgd]	[ɛːgt]	[ˈɛːgdə]	‘own’
[çyːl]	[çyːld]	[çyːlt]	[ˈçyːldə]	‘chill’
[vɛːv]	[vɛːvd]	[vɛːvt]	[ˈvɛːvdə]	‘weave’
[steːk]	[steːkt][20]	[steːkt]	[ˈsteːktə]	‘broil’

Note that the vowel is long in these forms, counter to Swedish monomorphemic stem phonotactics. That is, monomorphemes of the form [veːgd] [veːgt] [veːgde] are ungrammatical. This vowel lengthening is not the result of the affixation. If the infinitive has a short vowel and long coda consonant, the vowel remains short. The pattern applies generally to verbs of the form C_0VC of the second conjugation (Teleman et al. [henceforth, *SAG*] 1999:558); i.e., the conjugation with no stressless thematic vowel before the suffix:

(101)

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[tɪgː]	[tɪgd]	[tɪgt]	[ˈtɪgdə]	‘beg’
[hø̞jː]	[hø̞jd]	[hø̞jt]	[ˈhø̞jdə]	‘raise’
[fʏlː]	[fʏld]	[fʏlt]	[ˈfʏldə]	‘fill’
[dø̞mː]	[dø̞md]	[dø̞mt]	[ˈdø̞mdə]	‘judge’
[slɛ̞kː]	[slɛ̞kt][21]	[slɛ̞kt]	[ˈslɛ̞ktə]	‘extinguish’
[klɪpː]	[klɪpt]	[klɪpt]	[ˈklɪptə]	‘cut’

Similarly, if the suffix is preceded by a stressless vowel, the suffix consonant is short, and the vowel length in the affixed form mirrors the vowel-length of the stem. The

[20] I will abstract away from voicing assimilation.
[21] See previous footnote.

productive first conjugation features a thematic vowel /a/ after the stem; verbs of this group feature short stops in the relevant suffixes (*SAG* 1999:558):

(102)

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[viːl]	[ˈviːlat]	[ˈviːlad]	[ˈviːladə]	'rest'
[trɪlː]	[ˈtrɪlːat]	[ˈtrɪlːad]	[ˈtrɪlːadə]	'fall'

Returning to verbs with no thematic conjugational vowel, if the stem is of the form C_0V, the vowel surfaces as short in the suffixed form; not long, as we might have expected. The relevant words are of the so-called third conjugation (*SAG* 1999: 560). The suffix's dental stop is long.[22]

(103)

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[truː]	[trutː]	[trudː]	[ˈtrudːə]	'believe'
[floː]	[flotː]	[flodː]	[ˈflodːə]	'flay'
[flyː]	[flytː]	[flydː]	[ˈflydːə]	'flee'
[ɧeː]	[ɧetː]	[ɧedː]	[ˈɧedːə]	'occur'
[strøː]	[strøtː]	[strødː]	[ˈstrødːə]	'sprinkle'

In addition to the stems ending in a stressed vowel, another set of data generally subsumed under the title 'dental gemination' includes those verbs of the second conjugation which end in dental stops (*SAG* 1999: 559). Interestingly, these surface with a short vowel followed by a long dental stop. The following are stems of the form C_0Vt.

[22] In this chart and following charts, the short vowels have slightly different qualities than the corresponding long vowels, but I have left them identical, for expositional clarity. Vowel-vowel correspondence is discussed in chapter 4.

(104)

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[byːt]	[bytː]	[bytː]	[ˈbytːə]	‘exchange’
[møːt]	[møtː]	[møtː]	[ˈmøtːə]	‘meet’
[støːt]	[støtː]	[støtː]	[ˈstøtːə]	‘shove’
[mɛːt]	[mɛtː]	[mɛtː]	[ˈmɛtːə]	‘measure’
[ɧøːt]	[ɧøtː]	[ɧøtː]	[ˈɧøtːə]	‘treat’

The same changes in vowel-length apply to stems of the form C_0Vd.

(105)

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[føːd]	[føtː]	[fødː]	[ˈfødːə]	‘give birth’
[tyːd]	[tytː]	[tydː]	[ˈtydːə]	‘interpret’
[pryːd]	[prytː]	[prydː]	[ˈprydːə]	‘decorate’

The vowel length of the stem is lost in the suffixed forms, and the suffixes are long.

The ‘dental gemination’ pattern does not only apply to verbal conjugations, but also to adjectives. The neuter surfaces as /t/ after C_0VC stems. Just like in the verbs, the vowel-length is replicated in the affixed form:

(106)

STEM	NEUTER	GLOSS
[jʉːp]	[jʉːpt]	‘deep’
[rɑːk]	[rɑːkt]	‘straight’
[viːg]	[viːgt]	‘nimble’
[viːs]	[viːst]	‘wise’
[lɑːm]	[lɑːmt]	‘lame’
[heːl]	[heːlt]	‘whole’

If the vowel is short in the stem, it remains short in the affixed form:

(107)

STEM	NEUTER	GLOSS
[knapː]	[knapt]	'bare'
[çɛkː]	[çɛkt]	'smart'
[pigː]	[pigt]	'energetic'
[dəmː]	[dəmt]	'dumb'
[fəlː]	[fəlt]	'full'

Just like the verbs above, the stems of the form C_0V surface with a short vowel, rather than the expected long vowel:[23]

(108)

STEM	NEUTER	GLOSS
[bloː]	[blotː]	'blue'
[groː]	[grotː]	'grey'
[roː]	[rotː]	'raw'
[friː]	[fritː]	'free'
[nyː]	[nytː]	'new'
[sløː]	[sløtː]	'lazy'

The adjectives ending in dental stops also pattern like the verbs above: the following stems are of the form C_0Vt.

(109)

STEM	NEUTER	GLOSS
[viːt]	[vitː]	'white'
[voːt]	[votː]	'wet'
[heːt]	[hetː]	'hot'
[feːt]	[fetː]	'greasy; fat'

The same applies to stems of the form C_0Vd.

[23] Some adjectives resist neuter affixation, resulting in paradigm gaps (Sigurd (1965: 102-103), Kiefer (1970), Linell (1972), *SAG* (1999: 210, 214); Raffelsiefen (2002). This is discussed in chapters 4 and 5.

(110)

STEM	NEUTER	GLOSS
[glɑːd]	[glatː]	'happy'
[breːd]	[bretː]	'broad'
[døːd]	[døtː]	'dead'
[røːd]	[røtː]	'red'
[sneːd]	[snetː]	'crooked'
[sprøːd]	[sprøtː]	'crisp'
[viːd]	[vitː]	'white'
[bliːd]	[blitː]	'mild'
[soliːd]	[solitː]	'solid'

There are two questions that arise regarding the 'dental gemination' pattern.

(111) (a) What determines the long/short allomorphy of the suffix?

(b) What determines the long/short allomorphy of the stem?

We will first address question (111)(a), then question (111)(b).

3.3 Underlying Representations

To address question (111)(a) above, we must have a sense of the URs of relevant suffixes. Are they short in UR, and lengthened by a process of gemination? Or are they long in UR, and shortened by a process of degemination? Following Teleman 1969, I will assume the latter. Teleman (1969:203) makes an astute observation in his classic overview of the Swedish inflectional system:

> Nothing hinders us...from assuming /-tt/, /-dde/, /-dd/ as underlying representations for the suffixes. After all, these are reduced automatically...after a consonant or stressless vowel by a rule which we must have for independent reasons [....] With this assumption we can cancel the need for arbitrary

conjugation-markings in the lexicon for the generation of the different suffixes among the weak verbs.[24]

Teleman's insight is clear: with moraicity marked in the suffixes' UR, independent phonotactics can generate the short allomorphs of the suffixes. The following structures featuring long consonants are ungrammatical in Swedish:

(112) (a) CVCC:

(b) ˈCVCVC:

This means that independent phonotactic mechanisms, properly formalized, might alter the representations, generating short consonants:

(113) (a) CVCC

(b) ˈCVCVC

Note that the reverse case cannot be held: we cannot have the 'dental gemination' be forced by stem phonotactics. Recall that the geminate suffixes appear only after a stressed vowel. But a singleton C may freely appear after a stressed vowel in Swedish: the form CV:C is impeccable in terms of stem phonotactics, as the following examples illustrate.

[24] The translation is mine [IL]. The original reads:
Ingenting hindrar oss...från att anta /-tt/, /-dde/, /-dd/ som grundformer för suffixen. Dessa reduceras nämligen automatiskt...efter konsonant eller obetonad vokal av en regel som vi av andra skäl måste ha. Den dubbla klusilen kvarstår då bara där den ska stå, nämligen efter stam på lång vokal. Genom detta antagande kan vi helt avskaffa behovet av arbiträra konjugationsmärken i lexikon för generering av de olika suffixen i de svaga verben.

(114)

STEM	GLOSS
[jʉːp]	‘deep’
[viːt]	‘white’
[rɑːk]	‘straight’
[viːg]	‘nimble’
[viːs]	‘wise’
[lɑːm]	‘lame’
[heːl]	‘whole’

Following Teleman’s observation, we assume the following URs:

(115)

PARTICIPLE	SUPINE	PRETERITE	NEUTER
/dː/	/tː/	/dːə/	/tː/

3.4 Perceptually driven degemination

Assuming the geminate representation of the suffixes in UR, we must account for the fact that their degemination after a consonantal and after a stressless vowel is grammatical. Logically speaking, we might simply have a case of ineffability or haplology, since the surface realization of the suffix morpheme cannot appear unaltered in these contexts. Why is degemination grammatical in these contexts, but blocked after a stressed vowel? Donca Steriade (p.c.) suggests that the licensing of degemination of the geminate suffixes is sensitive to perceptibility: salience of gemination is identified in the P-map; and the grammar, in the form of ranked constraints, disprefers salient degemination.

We are interested in comparing geminate and non-geminate consonants; we will compare the sounds Cː and C. We will consider their confusability in three contexts: after a stressed vowel, after a stressless vowel, and after a consonant. A stark V-C

formant transition facilitates the segmentation of the consonant after a stressed vowel; so length alternation in the consonant (degemination) is salient in this context. The cues of segmentation are less stark after a stressless vowel and after a consonant. For this reason, the distinction C:/C is less salient in these contexts.[25]

(116)

Context / Sounds	V_ +stress	V_ -stress	C_
C:/C	C:/C	C:/C	C:/C

The grammar penalizes degemination less severely if the resulting degemination is relatively non-salient. It penalizes degemination more severely if the resulting degemination is relatively salient.

(117) **P-map-to-ranking projection of IDENT [Long C]/K**

For two contexts K_a and K_b, $a \neq b$, and a consonant C,

if Δ (C: / K_a , C / K_a) > Δ (C: / K_b , C / K_b)

then IDENT [Long C] / K_a $\gg$ IDENT [Long C] / K_b

Compare the contexts [$V_{+stress}$ _] and [$V_{-stress}$ _]:

(118) For two contexts [$V_{+stress}$ _] and [$V_{-stress}$ _],

if Δ (C: /$V_{+stress}$ _ , C /$V_{+stress}$ _) > Δ (C: /$V_{-stress}$ _ , C /$V_{-stress}$ _)

then IDENT [Long C] / $V_{+stress}$ _ $\gg$ IDENT [Long C] / $V_{-stress}$ _

Then, compare the contexts [$V_{+stress}$ _] and [C_]:

[25] The P-map fragment comparing a degemination after a stressed vowel and after a consonant is established in sections 6.8 and 6.9.

(119) For two contexts [$V_{+stress}$ _] and [C_i _],

if Δ (C:, C) in [$V_{+stress}$ _] > Δ (C:, C) in [C_],

then IDENT [Long C] / $V_{+stress}$ _ ≫ IDENT [Long C] / C _

These schemata generate the two following rankings:

(120) IDENT [Long C] / $V_{+stress}$ _ ≫ IDENT [Long C] / $V_{-stress}$ _

IDENT [Long C] / $V_{+stress}$ _ ≫ IDENT [Long C] / C _

Collapsing these, we have the following ranking:

(121) IDENT [Long C] / $V_{+stress}$ _

≫ IDENT [Long C] / $V_{-stress}$ _, IDENT [Long C] / C _

The suffix is true to its UR after a stressed vowel, since degemination would be overly salient in that context. The suffix is degeminated after a stressless vowel or after a consonant, since degemination is not so salient in these contexts.[26]

3.5 Variation in the stem

Having answered question (111)(a), let us now grapple with question (111)(b):

(122) = (111)

(b) What determines the long/short allomorphy of the stem?

Recall that vowel-length is replicated in CVC stems and in stems featuring a thematic vowel before the suffix. The following chart summarizes the pattern:

[26] I will return to gemination pattern in the case of dental-final stems below.

(123)

STEM-FINAL SOUND	VOWEL-LENGTH REPLICATED?	EXAMPLE
$V_{+stress}$	no	[truː] → [trudːə]
$V_{-stress}$	yes	[viːl] → [viːladə]
C	yes	[vɛːg] → [vɛːgdə]

Faithfulness of vowel-length is lost in the words that end in stressed vowels, but maintained in the words that end in either a stressless vowel or a consonant. Assume that maintenance of vowel-length is the result of an O-O constraint (McCarthy & Prince 1995; Benua 1997):

(124) O-O FAITH [V-LENGTH] The vowel length of a derived form is the same as the vowel-length of the stem.

Now recall the degemination ranking that we derived from the P-map:

(125) = (121) IDENT [Long C] / $V_{+stress}$ _

≫ IDENT [Long C] / $V_{-stress}$ _, IDENT [Long C] / C _

Vowel length is lost if the stem ends with a stressed vowel, and is maintained if the stem ends in a consonant or is followed by a stressless vowel. By interleaving O-O FAITH [V-LENGTH] between the first degemination constraint and the other two, we obtain the desired result:

(126) IDENT [Long C] / $V_{+stress}$ _

≫ O-O FAITH V-LENGTH

≫ IDENT [Long C] / $V_{-stress}$ _, IDENT [Long C] / C _

Before seeing how these constraints generate the relevant forms, a word on Swedish phonotactics is in order.

Swedish features long segments only in stressed syllables. All segments in unstressed syllables are short. Either the vowel is long, or the first coda consonant is long; it is not the case that both are long:

(127) *Vː Cː

A consonant is long only if it is preceded by a short stressed vowel. A long consonant may not be post-consonantal:

(128) *CC:

There is another phonotactic, which is very robust in the language. It is a ban on long vowels in closed syllables (modulo extrametricality, cf. Löfstedt 1992, Riad 1992).

(129) $*V:C]_{\sigma}$

Although the latter is exceedingly robust, there are two monomorphemic exceptions:

(130)

SR	GLOSS
[moːln]	'cloud'
[ɑːln]	'ell'

These words suggest that the phonotactic $*V:C]_{\sigma}$ is violable, and is therefore ranked lower than the phonotactics [*Vː Cː] and [*CC:].

(131) [*Vː Cː] , [*CC:]

≫ $*V:C]_{\sigma}$

Recall the degemination constraints:

(132) =(126) IDENT [Long C] / $V_{+\text{stress}}$ _

≫ O-O FAITH V-LENGTH

≫ IDENT [Long C] / $V_{-\text{stress}}$ _, IDENT [Long C] / C _

Consider how the markedness constraints and the degemination constraints are ranked with respect to each other. The markedness constraints [*Vː Cː] and [*CC:] are not violated in the language, so they are ranked highest. Also the degemination constraint IDENT [Long C] / $V_{+\text{stress}}$ _ is not violated.

(133) Unviolated [*Vː Cː] [*CC:] IDENT [Long C] / $V_{+\text{stress}}$ _

The markedness constraint *V:C]$_\sigma$ remains to be ordered with respect to the other degemination constraints. Affixed C_0VC stems show us the appropriate ordering.

(134)

STEM	PRETERITE	GLOSS
[vɛːg]	[vɛːgde]	'weigh'

Although the language does not permit monomorphemes of the form CVːC.CV, the affixed form here features a long vowel before a consonant that is syllabified in the coda. This means that O-O FAITH [V-LENGTH] is ranked higher than *V:C]$_\sigma$. It is better to have a long vowel before a coda consonant than to lose intraparadigmatic faithfulness of vowel-length .

So, we have the following rankings:

(135) [*V:C:] [*CC:] IDENT [Long C] / $V_{+\text{stress}}$ _

≫ O-O FAITH V-LENGTH

≫ *V:C]$_\sigma$ IDENT [Long C] / $V_{\text{-stress}}$ _ IDENT [Long C] / C_

Consider how they generate the appropriate output for the 'dental gemination' pattern. First, take the case of /tru + dːe/.[27]

[27] For expositional clarity, I am abstracting away from the shift in vowel quality in the shortening process. This is discussed in chapter 4.

(136)

	/tru + dːə/ [truː] 'believe, pret.'	*VːCː	*CCː	IDENT [Long C] / $V_{+stress}$—	O-O FAITH V-	*Vː$C]_{\sigma}$	IDENT [Long C] / $V_{-stress}$—	IDENT [Long C] / C_
a.	ˈtruːdːə	*!						
b. >	ˈtrudːə				*			
c.	ˈtruːdə			*!		*		

The fully faithful candidate is ruled out due to an unviolated phonotactic constraint of Swedish: it features the ungrammatical combination of a long vowel followed by a long consonant. We have then the choice between the candidate with a long suffix consonant—candidate (b)—or the candidate with a long stem vowel—candidate (c). Both are phonotactically well-formed. However, since the constraint IDENT [Long C] / $V_{+stress}$— outranks the constraint O-O FAITH V-LENGTH, candidate (b) is optimal.

Now, consider the case of a [vɛg + dːə], where the unaffixed form surfaces with a long vowel [vɛːg].

(137)

	/vɛg + dːə/ [vɛːg] 'weigh, pret.'	*VːCː	*CCː	IDENT [Long C] / $V_{+stress}$_	O-O FAITH V-	*Vː$C]_{\sigma}$	IDENT [Long C] / $V_{-stress}$_	IDENT [Long C] / C_
a.	ˈvɛːgdːə		*!					
b.	ˈvɛgdːə		*!		*			
c. >	ˈvɛːgdə					*		*
d.	ˈvɛgdə				*!			*

The fully faithful candidate violates the phonotactic against a post-consonantal geminate. Candidate (b) does this, as well; in addition to violating O-O FAITH [V-LENGTH]. We can choose, then, between candidates (c) and (d). Candidate (c) violates the general stem phonotactic against a vowel followed by a coda consonant, while candidate (d) violates O-O FAITH [V-LENGTH]. Since O-O FAITH [V-LENGTH] outranks *Vː$C]_{\sigma}$, the candidate that violates *Vː$C]_{\sigma}$ is the optimal one.

3.6 Dental-final stems

Let us now turn to the case of dental-final stems. Recall that the dental stop surfaces as long, and the preceding vowel is short, unfaithful to the long vowel of the stem form:

(138)

STEM	SUFFIX	PRETERITE FORM	GLOSS
[lyːd]	[dːe]	[lydːe]	'obey'

Before formalizing the issue, a question arises: What is the source of this gemination of the preterite form? In particular, is it the result of coalescence, or is it the result of the geminate marking on the suffix?

(139) 1 COALESCENCE HYPOTHESIS: Coalescence triggers gemination.

2 LEXICAL HYPOTHESIS: Lexically marked suffixes geminate.

Take the COALESCENCE HYPOTHESIS. Generally, geminate suffixes surface as geminate after homorganic stem-final consonants. The following illustrates the pattern in the verb paradigms:

(140)

	C_0V	C_0Vd	
STEM	[truː]	[lyːd]	
SUPINE	[trudː]	[lydː]	*gemination*
PARTICIPLE	[trudː]	[lydː]	*gemination*
PRETERITE	[trudːe]	[lydːe]	*gemination*
GLOSS	'believe'	'obey'	

Note that the structures of the C_0Vd stems are isomorphic with the structures of the C_0V stems.

The same is true for the adjectival pattern:

(141)

	C_0V	C_0Vt	
STEM	[nyː]	[viːt]	
NEUTER	[nytː]	[vitː]	*gemination*
GLOSS	'new'	'white'	

Just as the CV stem surfaces with a geminate suffix, the CVt stem surfaces with a geminate suffix.

However, if the suffix is not geminate, coalescence does not trigger gemination. Take the present tense suffix. It surfaces as singleton /r/ after vowels, and as /ər/ after consonants (e.g., [stɛ̣lː] 'to place'; [stɛ̣lːər] 'place, pres.'). After a stem ending in /r/, however, the result is haplology:

(142)

	C_0V	C_0Vr	
STEM	[truː]	[røːr]	
PRESENT	[truːr]	[røːr]	*haplology*
GLOSS	'believe'	'touch'	

This is not a phonotactic effect. There is no ban on geminate [rː] in Swedish:

(143)

MONOMORPHEMIC STEM	GLOSS
[barː]	'pine needles'
[klɪrː]	'sound of breaking glass'
[stɪrː]	'stare'

Nevertheless, the r-final stems trigger haplology in the present, since the suffix is marked as non-moraic. This is not restricted to the word 'touch' above. It applies generally to r-final stems

(144)

STEM	PRESENT	*	GLOSS
[çøːr]	[çøːr]	*[çørː]	'drive'
[hyːr]	[hyːr]	*[hyrː]	'rent'
[styːr]	[styːr]	*[styrː]	'stear'
[bəjɛːr]	[bəjɛːr]	*[bəjɛrː]	'desire'
[lɛːr]	[lɛːr]	*[lɛrː]	'teach'
[tɛːr]	[tɛːr]	*[tɛrː]	'consume'
[føːr]	[føːr]	*[førː]	'lead'

[høːr]	[høːr]	*[hørː]	'hear'
[støːr]	[støːr]	*[størː]	'disturb'

The same effect can be seen in the genitive suffix –s.

(145)

	CV	CVs	
STEM	[øː]	[grɛːs]	
GENITIVE	[øːs]	[grɛːs]	*haplology or* INEFFABLE
GLOSS	'island'	'grass'	

Dialects differ as to the acceptability of the haplological genitive. Some native speakers use the haplological genitive, while others prefer periphrasis. Sigurd (1965:101) notes that 'genitive forms of such nouns are in fact avoided as far as possible.' On the other hand, *SAG* (1999) regards the result as haplological, not ineffable. Setting aside interesting sociolinguistic questions, the choice of either haplology or ineffability applies to s-final stems.

(146)

STEM	GENITIVE		*	GLOSS
[ruːs]	[ruːs]	or INEFFABLE	*[rusː]	'rose'
[iːs]	[iːs]	or INEFFABLE	*[isː]	'ice'
[vɑːs]	[vɑːs]	or INEFFABLE	*[vasː]	'vase'

Note that the alternative with geminate [sː] is never an option. Again, this ungrammaticality is not due to stem phonotactics. The language is rich in words ending in geminate [sː].

(147)

STEM	GLOSS
[glasː]	'ice cream'
[ɛ̝sː]	'ace'
[drɛ̝sː]	'outfit'
[hɪsː]	'elevator'

[klɔsː] 'block'

[pəsː] 'kiss'

[krʏsː] 'crossing'

The combination (C_i + C_iː) generates geminate C_iː . However, the combination (C_i + C_i) generates singleton C_i or ineffability. Gemination under coalescence takes place only if the suffix is marked as long in UR.

The COALESCENCE HYPOTHESIS is empirically untenable. So, we will assume the LEXICAL HYPOTHESIS above: the 'dental gemination' pattern takes place with homorganic stems because the suffixes are marked as geminate in UR. Suffixes such as the present tense /r/ and genitive /s/, on the other hand, are marked as non-moraic in UR, so they do not trigger gemination under coalescence.

We are now almost ready for the formalization of the dental-final stems. A word of explication is in order, however. Recall that we used the following constraints on degemination to capture the lack of degemination after a stressed vowel, contrasted with degemination in post-consonantal position and after a stressless vowel.

(148) =(121) IDENT (Long C) / $V_{+\text{stress}}$ __]

≫ IDENT (Long C) / $V_{-\text{stress}}$ __], IDENT (Long C) / C __]

In the examples we have seen up to now, a vagueness in the formalism has gone unnoted. The vagueness is the following: are the contexts defined in UR or SR? Since there has been no deletion or epenthesis up to now, the question would appear to be academic. However, in the case of the dental-final stems, the question is concrete and empirical. Take the form /lyd + dːe/ 'obey, preterite'.

(149)

		CONTEXT OF SUFFIX
UR	/lyd + dːe/	C_
SR	[lydːe]	V_

In UR, the geminate stop of the suffix is post-consonantal: it follows the /d/ of the stem. But in SR, the geminate stop of the suffix is post-vocalic.

If the IDENT (Long) constraint were to access UR to define its context, the preterite of 'obey' should surface with a long vowel; this is an incorrect output:

(150)

lyd + dːə 'obey, pret.' Cf. [lyːda]	*Cː	IDENT (LONG C) /V$_{+STRESS}$_	O-O FAITH V- LENGTH	*V:C]$_{\sigma}$	IDENT (LONG C) /V$_{-STRESS}$_	IDENT (LONG C) /C_
a. lydːə	*!					
b. lydːə			*!			
c. lyːdə						*

If the IDENT (Long C) constraint accesses SR to define its context, the preterite of 'obey' surface with a short vowel; this is the correct output:

(151)

	lyd + dːə ‘obey, pret.’ Cf. [lyːda]	*Cː:	IDENT (LONG C) /V$_{+\text{STRESS}}$_	O-O FAITH V- LENGTH	*V·C]$_{\sigma}$	IDENT (LONG C) /V$_{-\text{STRESS}}$_	IDENT (LONG C) /C_
a.	lydːːə	*!					
b. >	lydːə			*			
c.	lyːdə		*!				

So the context of the constraint must be defined at SR.

3.7 Previous accounts

The account provided above is not the first attempt at covering the pattern called ‘dental gemination’. I will presently review previous proposals.

3.7.1 Eliasson & la Pelle 1973

Eliasson & la Pelle provide an *SPE*-type rule-based approach to ‘dental gemination’. The relevant suffixes are short in UR, but lengthened by a rule of gemination, formalized in the following way:

(152) Gemination of dental stops

$$\varnothing \rightarrow C_1 \,/\, V \_\_ + C_2, \text{ where } C_1 = C_2 = \begin{bmatrix} \text{-son} \\ \text{+cor} \\ \text{-cont} \end{bmatrix}$$

To handle the stems ending in dental stops, which pattern like the words that are vowel-final, they also posit a rule of morpheme-boundary deletion:

(153) Deletion of morpheme boundary +

$$+ \rightarrow \varnothing \quad / \; C_1 \_ \; C_2$$

$$\text{where } C_1 = C_2 = \begin{bmatrix} \text{-son} \\ \text{+cor} \\ \text{-cont} \end{bmatrix}$$

The long vowel in consonant-final stems (where the consonant is not a dental stop) is the result of the general rule of vowel lengthening:

(154) Vowel lengthening

$$\begin{bmatrix} \text{V} \\ \text{+stress} \end{bmatrix} \rightarrow [+\text{tense}] \; / \qquad \_ \; (\text{C} \; (\{\text{r, l, n}\}\;)) \; \{+\text{V}\}$$

A consonant that follows a stressed short vowel is lengthened:

(155) Consonant lengthening

$$\text{C} \rightarrow [+\text{long}] \; / \; \begin{bmatrix} \text{V} \\ \text{+stress} \\ \text{-long} \end{bmatrix} \_\_$$

Then, the consonant that follows the [+long] consonant is deleted.

(156) Degemination

$$\text{C}_1 \rightarrow \varnothing \quad / \qquad \begin{bmatrix} \text{C}_2 \\ \text{+long} \end{bmatrix} (+) \; \_\_$$

The following examples illustrate the application of the rules mentioned above:

(157)	tru + de	lyd + de	mal + de
gemination	trud + de		mal + de
+ -deletion	trudde	lydde	
V-lengthening			maːl + de
C-lengthening	trudːde	lydːde	
Degemination	trudːe	lydːe	

The main problem for Eliasson & la Pelle's approach is conceptual: while the rules do generate an appropriate output, they are unconstrained in their form. As Witting 1977 notes, it is conceptually dubious to have both a gemination and a degemination rule; this constitutes a Duke-of-York effect.

Also, one might ask precisely why the gemination rule only applies to the dental stops. Phonotactically speaking, a non-geminate dental stop after a morpheme boundary is perfectly grammatical in non-standard dialects of Swedish. While the neuter definite article surfaces as [ət] in standard Swedish, Teleman 1969 correctly notes that the alternative [t] arises in other dialects:

(158) SG. = STEM	NONSTANDARD N. SG. DEF.	*	GLOSS
[ɑː]	[ˈɑːt]	*[ɑtː]	'letter A'
[teː]	[ˈteːt]	*[tetː]	'tea'
[buː]	[ˈbuːt]	*[butː]	'nest'
[kʉː]	[ˈkʉːt]	*[kʉtː]	'letter Q'
[blyː]	[ˈblyːt]	*[blytː]	'lead'
[stroː]	[ˈstroːt]	*[strotː]	'straw'
[trɛː]	[ˈtrɛːt]	*[trɛtː]	'wood'
[spøː]	[ˈspøːt]	*[spøtː]	'rod'

The account also undergenerates gemination. Take the comparative suffix /rə/. The suffix is usually is preceded by a thematic vowel /a/, so that the /r/ is in a stressless syllable, and short:

(159)

POSITIVE	COMPARATIVE
[lɛ̝tː]	[lɛ̝tːarə]
[røːd]	[røːdarə]

If a stem ends in a stressed vowel, however, the comparative surfaces with a geminate /r/.

(160)

	C_0V	C_0Vr
POSITIVE	[foː]	[stuːr]
COMPARATIVE	[fɛ̝rːe]	[stø̞rːe]
GLOSS	'few'	'big'

Since /r/ is not a dental stop, this effect cannot be captured using Eliasson & laPelle's rules.

3.7.2 Witting 1977[28]

As Witting 1977 criticizes Eliasson & la Pelle's account for the Duke-of-York abstractness, it is perhaps unsurprising that his account is more economical. Witting's account of 'dental gemination' involves the rule 'Inhibition of vowel-lengthening'. While this rule is not formalized, the reader can sense what it achieves: since the vowel before the relevant suffixes is blocked from lengthening, and Swedish stressed syllables require either a long vowel or a long coda-initial consonant, then the dental will

[28] The account of gemination in Stemberger 1981 relies on Witting 1977.

lengthen to satisfy the phonotactic requirements. Witting provides the following illustration:

(161)	UR	/tru + de/
	Stress and tone	^{x}trude
	Inhibition of vowel lengthening	^{x}trude
	Danell's rule 'long C after short stressed V'	^{x}trud:e

As the mechanism of 'Inhibition of vowel lengthening' is not rendered explicit, it is difficult to evaluate it. There are unanswered questions: Why is vowel lengthening blocked before these suffixes, and not others? Why is it blocked only in vowel-final stems, and not in stems ending in singleton consonants?

The lack of explicit formalism becomes more acute in the case of stems ending in dental stops. Witting (1977:41) provides the following derivation:

(162) Our derivation of *lydde* turns out thus:

1. /lyyd + de/, 2 ^{x}lyydde, 3 ^{x}lydde (surface form ^{x}lyd:e])

Stage 2 corresponds to stage 2 for *trodde*. Stage 3 is the result of the functioning of two rules: (1) morpheme protection pertaining to the *d* of the suffix, and (2) Danell's formula.

'Morpheme protection' is defined as the 'communicative necessity of keeping the suffixes auditorily distinct' (Witting 1977:95). However, it is not formulated explicitly. Whatever Witting has in mind, it should be noted that Swedish does feature haplology in the genitive, present tense, participle, and the non-neuter definite article.

(163)	UR		HAPLOLOGICAL FORM
genitive -s	/ɡrɛs + s/	→	[ɡrɛːs]
present tense	/røːr + r/	→	[røːr]
participle	/vɛ̝nd + d/	→	[vɛ̝nd]
non-neuter –en	/mʏrtən + ən/	→	[mʏrtən]

It is difficult to evaluate Witting's proposal, given its vagueness.

3.7.3 Raffelsiefen 2002

Raffelsiefen 2002 accounts for the 'dental gemination' pattern by referring to minimality. Crucially, the author assumes that only long consonants (not short consonants) are moraic in Swedish. Also, long vowels are monomoraic; just like short vowels. The long vowels are 'stretched' according to Raffelsiefen; they are not prosodically marked as long. So, monosyllabic forms without long coda consonants violate minimality. She defines minimality as follows:

(164) MIN

Morphologically marked words must be minimally bimoraic.

Assuming that 'morphologically marked' signifies 'minimally bimorphemic', the rule only applies to derived forms. As Raffelsiefen (2002:32) notes, '...MIN ensures syllable closure but does not necessarily determine the site of stretching.' For this, an additional constraint is necessary:

(165) AMBI [S-site]

Ambisyllabic consonants are stretching sites.

Raffelesiefen assumes that word-final codas are ambisyllabic, linked to an abstract second syllable.

The ‘stretching’ of vowels in words ending in consonants (other than dental stops) is the result of an O-O constraint:

(166) O-O IDENT [S-site]

The stretching site must be identical for all members of a paradigm

Let us see how her constraints produce their outputs. First, take a CV stem like /ny/ ‘new’:

(167)

	/ny +t/ ‘new, n.’cf. [nyː]	MIN	AMBI [S-site]	O-O IDENT [S-SITE]
a.	ny_{μ} ːt	*!		
b.	ny_{μ}ːt$_{\mu}$		*!	
c. >	ny_{μ}tː$_{\mu}$			*

Candidate (a), being monomoraic, violates MIN. Candidate (b), satisfies MIN, by virtue of being bimoraic. However, it violates AMBI [S-SITE], since the abstractly ambisyllabic consonant /t/ is not a stretching site, as the constraint requires. Candidate (c) violates the O-O constraint on paradigm-uniformity w.r.t. vowel length, but this constraint is ranked lower than MIN and AMBI [S-SITE], so the candidate is regarded as optimal.

I believe that reducing ‘dental gemination’ to Minimality is problematic: this account both overgenerates and undergenerates. It overgenerates gemination in the suffixes marking present tense (/r/), plural (/r/), non-neuter definite (/n/), and genitive (/s/). As mentioned above, these suffixes never geminate.

(168)

	STEM	SUFFIXED	*	GLOSS
PRESENT TENSE	[buː]	[buːr]	*[burː]	'live'
PLURAL	[kuː]	[kuːr]	*[kʊrː]	'cow'
GENITIVE	[feː]	[feːs]	*[fesː]	'fairy'
PASSIVE	[floː]	[ˈfloːs]	*[ˈflosː]	'flay'
DEFINITE	[frʉː]	[frʉːn]	*[frʉnː]	'wife'

Only one example of each is given above, but dozens more could be given: the pattern is general and productive. Raffelsiefen is aware of problem, and makes the following speculation (Raffelsiefen 2002:36):

> One possible interpretation...is that Swedish suffixes have been historically associated with a mora in the lexicon. [...] Once a suffix has been moraified, minimality effects are bound to cease. This is because moraification of suffixes ensures the satisfaction of bimoraicity....[...] The historical moraification of suffixes is manifested by the emergence of doublets [seːs] [sesː], where the augmented forms are bound to become obsolete because of gratuitous OO-IDENT [S-SITE] violations.

But this solution seems problematic. The passive suffix /s/ is short, not long.[29] The regular pattern suggests maintenance of non-moraicity, not moraification.

Raffelsiefen's account also seems to undergenerate, in the case of the plural participle forms. The plural participle is the result of the concatenation of two suffixes, the participle, which surfaces as /dː/ after a stressed vowel, and the plural suffix /a/. Together, then, they form the complex suffix combination /dː+a/. Since [a] is moraic, this should satisfy MIN, the driving force behind gemination. According to

[29] I am not familiar with a dialect with the form [sesː].

Raffelsiefen's account, no gemination should occur, since MIN is trivially satisfied by the vowels:

(169)

	/gnu + d + a/ 'rub, prt. pl.'	MIN	AMBI [S-site]	O-O IDENT [S-SITE]
a. 💣	gnu_{μ}:da_{μ}			
b.	gnu_{μ}:$d_{\mu}a_{\mu}$		*!	
c.	$gnu_{\mu}d_{\mu}$:a_{μ}			*!

However, the attested forms has a geminate /d:/. This is true for all of the plural participles that follow a stressed vowel. Here are some examples:

(170)

STEM	PL PARTICIPLE	*	GLOSS
[gnu:]	[ˈgnud:a]	*[ˈgnu:da]	'rub'
[flo:]	[ˈflod:a]	*[ˈflo:da]	'flay'
[klo:]	[klod:a]	*[klo:da]	'thrash'
[ɧy:]	[ˈɧyd:a]	*[ˈɧy:da]	'avoid'
[ɧe:]	[ˈɧed:a]	*[ˈɧe:da]	'occur'
[strø:]	[ˈstrød:a]	*[ˈstrø:da]	'sprinkle'

3.7.4 Löfstedt 1992

According to Löfstedt 1992, vowel length in Swedish is derived cyclically. In each cycle, a stressed vowel in an open syllable is associated to a second mora. Since

word-final segments are extrametrical, this generates long vowels in words of the structure CVC + C.

The vowel-lengthening process has five steps:

(171)

1 syllabification

2 stress assignment

3 mora projection

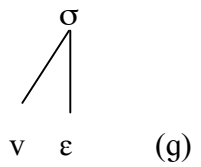
4 well formedness condition:

A syllable is bimoraic iff it is stressed

5 no stray moras, no stray segments

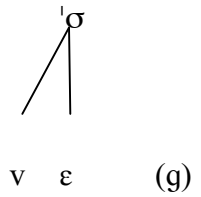
Consider how these five steps apply to the bimorphemic word [[vɛg]t] ‘weigh, supine’, which surfaces as [vɛːgt], with a long vowel. In cycle 1, the grammar has access to the stem [vɛg], which is syllabified:

(172) 1 syllabify (wordfinal C extrasyllabic)



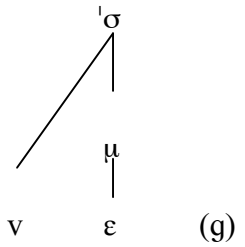
Note that the word-final consonant is extrametrical. Then, stress is assigned by rule. Since the item is monosyllabic, the unique syllable is stressed:

(173) 2 assign stress by rule



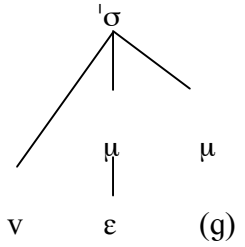
Now, the vowel projects a mora:

(174) 3 project moras



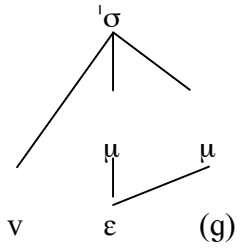
Since the syllable is stressed, it projects a second mora (unstressed syllables project only one mora).

(175) 4 A syllable is bimoraic iff it is stressed



To circumvent stray erasure of the second mora, the vowel associates with it in step 5:

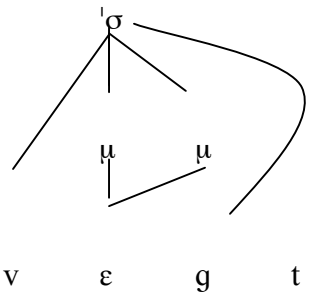
(176) 5 No stray moras, no stray segments



This marks the end of the first cycle.

In the second cycle, the suffix [t] is accessible to the grammar. The sound [g] is no longer extrametrical, but associated with the syllable:

(177) 1 syllabify (wordfinal C extrasyllabic)



The remaining steps 2-5 apply, but they do so vacuously, as no prosodic information is added to the output:

(178)	2	assign stress by rule	n/a
	3	project moras	n/a
	4	A syllable is bimoraic iff it is stressed	n/a
	5	No stray moras, no stray segments	n/a

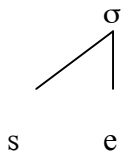
The post-vocalic /g/ is extrametrical in the first cycle, thereby letting the vowel associate to the second mora of the stressed syllable. This association is not altered in later cycles.

Notice that this account provides the appropriate vowel lengthening in words of the structure CVC+C, since the consonant before the morpheme boundary is extrametrical at the point of mora projection in step 5 of cycle 1. Notice furthermore that this incorrectly predicts that a vowel will be lengthened in all words of the structure CV +C. In step 4 of cycle 1, a second mora will be projected by the stressed syllable,

and this will associate with the vowel in step 5, since there is no post-vocalic consonant to refer to.

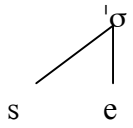
Consider a derivation of the word [[se]t] ‘see, supine’, with the SR [set:]. In cycle 1 step 1, the word is syllabified:

(179) 1 syllabify (wordfinal C extrasyllabic)



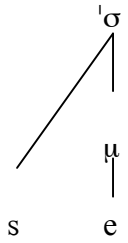
Stress is assigned in step 2.

(180) 2 assign stress by rule



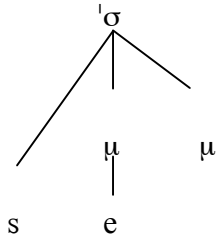
Since there is only one syllable, it is stressed. In step 3, the vowel projects a mora:

(181) 3 project moras



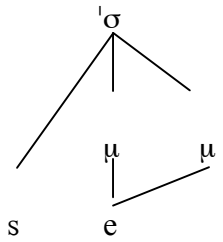
Step 4 is the crucial step. Here the syllable projects a second mora, since the syllable is stressed:

(182) 4 A syllable is bimoraic iff it is stressed



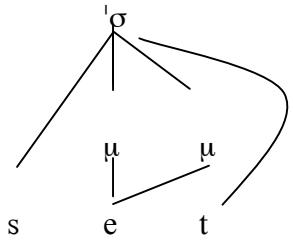
This second mora is associated with the vowel in step 5, such that stray erasure does not apply to the mora:

(183) 5 No stray moras, no stray segments



In cycle two, the suffix is accessed by the grammar, but crucially vowel length is already set at this point, and cannot be undone:

(184) 1 syllabify (wordfinal C extrasyllabic)



Steps 2-5 apply vacuously once again:

(185)	2	assign stress by rule	n/a
	3	project moras	n/a
	4	A syllable is bimoraic iff it is stressed	n/a
	5	No stray moras, no stray segments	n/a

So, a cyclic derviation of vowel length incorrectly provides the SR [seːt] for 'see, supine', where the correct form would be [setː].

Quite generally, a cyclic account fails to generate a difference between CVC + C forms, on the one hand, and CV + C forms, on the other. Since vowel lengthening in the CVC + C pattern is motivated by morpheme-final extrametricality, the form CVC + C is in fact treated as CV(C) + C; that is, with the stem ending in a vowel. Any difference between this and CV + C eludes explanation.

3.8 Local Summary

In the previous sections, we have shown that the so-called 'dental gemination' pattern in Swedish morphophonology is neither limited to dentals, nor does it involve gemination. Rather, it is the result of contextually determined degemination of suffixes that are marked as long in UR (Teleman 1969). The degemination is grammatical when relatively nonsalient; this is why the geminate suffixes can surface as short after a consonant or after an unstressed vowel. Degemination is ungrammatical when salient; this is why the geminate suffixes must surface as long after a stressed vowel. The salience of degemination is captured in the P-map, and this is translated into the grammar in the forms of ranked constraints.

4 Vowel-vowel correspondence and *MAP

4.1 Overview

Correspondence between Swedish vowels makes reference to the perceptual distance between the vowels and the paradigm type of the word (inflectional versus derivational).

Linell et al (1971:39 ff.) note that length and tenseness are correlated: a given vowel can be either both long and tense or both short and lax. In some parts of the grammar, a long and tense vowel can alternate with a corresponding short and lax one. In other parts of the grammar, the long and tense vowel fails to alternate with its corresponding pair. Failed correspondence results in exceptionally blocked coalescence, exceptional segment length, paradigm gaps ('ineffability'), and exceptional paradigms.

There are two factors that influence the grammar of vowel correspondence. The first factor is perceptual distance between the vowels in correspondence. The grammar penalizes correspondence between vowels more severely as the distance between the vowels increases. The other factor is paradigm type. Inflectional paradigms have tighter requirements of similarity between alternating segments than do non-inflectional (derivational) paradigms.

The analysis presented below involves Zuraw's (2007) *MAP constraint, relativized to paradigm type. The grammar penalizes any mapping from segment X in string S_1, to segment Y in string S_2; the greater the perceptual distance between X and Y, the more highly ranked the *MAP constraint. The relativization of *MAP to paradigm type ensures that a mapping in an inflectional form is more severely penalized than an identical mapping in a non-inflectional (derivational) form.

The analysis constitutes an argument against Evolutionary Phonology (Blevins 2004), in that the phonological system makes direct reference to primary content; in this

case, the primary content is perceptual distance. From an evolutionary perspective, there is no reason why two vowels with a great perceptual distance would fail to alternate in only one part of the grammar, when they do alternate in another part of the grammar.

4.2 Some processes that influence vowel length

The present study involves correspondence between long and short vowels. To understand the arguments presented, some knowledge of the correspondence relations is required. Some alternations apply between UR and SR; that is, I-O correspondence. Other alternations apply between distinct SRs within a paradigm; that is, O-O correspondence. The mechanisms of length-alternation in the present section are directly related to the phonotactics reviewed in the Introduction. I will first review the various sources of correspondence, and then discuss each one in some detail.

4.2.1 Templatic gemination

The first source of intraparadigmatic vowel-length alternation involves nicknames. Nicknames have a C_0VCːə template (Riad 2002). The second consonant in the template is always geminate, and the preceding vowel is always short.

Take a name whose unique or initial vowel is in a stressed open syllable (modulo extrametricality). The vowel in the SR of the non-hypocoristic form will be long, for reasons discussed in the previous section. The vowel in the hypocoristic form, however, will be short, because of the structure of the hypocoristic template.

(186)

LONG VOWEL	SHORT VOWEL	GLOSS
ˈkl[ɑː]s	ˈkl[a]sːə	‘Klas’, nickname
ˈkn[ʉː]t	ˈkn[ɵ]tːə	‘Knut’, nickname

Generally, in names with a long vowel in the non-hypocoristic form, the vowel-length in the nickname will be different from the vowel length in the non-hypocoristic name. Since these vowels alternate, they constitute a case of O-O correspondence.

4.2.2 Stress shift

Another source for alternation between long and short vowels involves stress-shifting suffixes. In the present study, we will focus on the suffix *–isk.* Much like the cognate English suffix *–ic*, the suffix *–isk* attracts stress to the immediately preceding syllable. That is, the stem-final syllable is stressed. If the stem ends in an open syllable (modulo extrametricality), then the stem-final vowel in the *–isk* form will be long. If, furthermore, the unaffixed form is not stressed on the final syllable, then that stem-final vowel will be short. This is so, since the vowel in an unstressed syllable is always short. Consider the following examples:

(187)

SHORT VOWEL	LONG VOWEL	GLOSS
ˈbals[a]m	balˈs[ɑː]m + isk	‘balsam/balsamic’
ˈtalm[ɵ]d	talˈm[ʉː]d + sk	‘Talmud/Talmudic’

In the left-hand column, the stem-final vowels are unstressed and therefore short. In the right-hand column, the stem-final vowels are open and stressed; therefore they are long. So, stress-attracting suffixes like *–isk* provide examples of O-O correspondence holding between short and long vowels.

4.2.3 Blocked coalescence of voiced dentals

Swedish features a phonological phenomenon of coalescence, which takes place when /r/ is followed by a dental consonant /d, n, l, s, t/ (Linell et al. 1971, Eliasson & LaPelle 1973, Hellberg 1974, Eliasson 1975, Schmid 1987, Börjars 1988). Coalescence influences vowel length, and results in correspondence relations between short vowels in UR and long vowels in SR.

When the sound /r/ is followed by a voiced dental /d, n, l/, the sequence coalesces into a voiced post-alveolar [ɖ, ɳ, ɭ][30]. The derived post-alveolars [ɖ, ɳ, ɭ] are generally short. Following the general phonotactic patterns, a stressed vowel preceding the voiced post-alveolar is generally long. Consider one example:

(188)	UR	SR	*	GLOSS
LONG VOWEL	/urd/	[uː]ɖ	*[ʊ]rd	'word'

Since vowels are not long in UR, the long vowel in SR before a voiced post-alveolar constitutes another example of I-O correspondence between a short vowel (UR) with a long vowel (SR).

4.2.4 Exceptional vowel length before voiceless post-alveolars

The voiceless post-alveolars also illustrate an instance of correspondence between short and long vowels. A voiceless post-alveolar [ʂ, ʈ] is formed from the sound /r/ followed by a voiceless dental /s, t/; in stressed syllables [ʂ, ʈ] generally surface as long. A vowel before the voiceless post-alveolar is generally short. The following is an example:

---

[30] There is no reason to assume that the post-alveolars are listed in UR. First, post-alveolarization applies across morpheme boundaries (e.g., /hør + d/ → [høːɖ] 'hear, past prt.'). Second, if they were in UR, there would be unexplained phonotactic gaps of the type [rd], [rl], [rn], [rs] and [rt]. When native speakers enunciate carefully, the [r] is clearly pronounced (Linell et al. 1971:104).

(189)	UR	SR	*	GLOSS
SHORT VOWEL	/kors/	k[ɔ]ʂː	*k[oː]ʂ	‘cross’

In some exceptional words, the voiceless post-alveolars [ʂ , ʈ] surface as short in a stressed syllable. In this case, the vowel before [ʂ , ʈ] surfaces as long. The following is an example:

(190)	UR	*	SR	GLOSS
LONG VOWEL	/lars/	*l[a]ʂː	l[ɑː]ʂ	‘Lars, a name’

Since vowel length is not marked in UR, this vowel lengthening constitutes an example of I-O correspondence between short (UR) and long vowels (SR).

4.2.5 Geminate suffixes

Verbal and adjectival morphophonology provides another source of correspondence between long and short vowels. Some verbal and adjectival suffixes have geminate consonants as their initial (or unique) segment. When these suffixes attach to a C_0V stem, they close the syllable. The following chart provides some examples of the pattern:

(191)

VERB		ADJECTIVE	
SR	GLOSS	SR	GLOSS
ˈtr[uː]	‘believe, inf’	ˈn[yː]	‘new, pos’
ˈtr[ʊ]tː	‘believe, sup’	ˈn[ʏ]tː	‘new, comp’
ˈtr[ʊ]dː	‘believe, part’		
ˈtr[ʊ]dːə	‘believe, pret’		

A stem with UR C_0V will surface as C_0Vː in the unaffixed form; the vowel will be lengthened due to phonotactics. On the other hand, the affixed form will surface as C_0VCː, with a short vowel before the geminate suffix consonant. The long vowel in the

unaffixed form and the short vowel in the affixed form constitute an instance of O-O correspondence.

This marks the end of the overview of sources of correspondence. Each case will now be discussed in greater detail.

4.3 Alternating vowels

4.3.1 Nicknames

Eliasson (1978) draws attention to systematic correspondences between long and short variants of vowels in Swedish nicknames. Nicknames are formed with a /C_0VCːə/ template (Noréen 1903-24, Tegnér 1930, Modéer 1965, Eliasson 1980, Thun 1992, Riad 2002). The first C_0 corresponds to the consonant cluster preceding the stressed vowel; since most names are monosyllabic or trochaic, this usually refers to the initial (possibly null) cluster of the name. The short V corresponds to the stressed vowel of the first name. Note that the vowel need not be short in the full form of the name, although it must be short in the hypocoristic form. The long Cː corresponds to one of the post-vocalic consonants in the full name.[31]

The following chart shows typical name/nickname pairs. I have grouped the names by the alternating vowels.

(192)

	FULL NAME (LONG V)	NICKNAME (SHORT V)
Δ (ɑ , a)	kl[ɑː]s	kl[a]sːə
	[ɑː]gəst	[a]gːə
Δ (ʉ , ə)	kn[ʉː]t	kn[ə]tːə

[31] For a detailed discussion about consonant correspondences in nicknames (among other details) see Riad 2002.

	h[ʉː]bert	h[ɵ]bːə
Δ (ɛ , ɛ̝)	p[ɛː]r	p[ɛ̝]rːa
Δ (y , ʏ)	st[yː]rbjørn	st[ʏ]bːə
Δ (e , ɛ̝)	st[eː]fan	st[ɛ̝]fːə
Δ (o , ɔ)	r[oː]land	r[ɔ]lːə
	p[oː]l	p[ɔ]lːə
Δ (u , ʊ)	[uː]lof	[ʊ]lːə
	b[uː]	b[ʊ]sːə
Δ (i , ɪ)	m[iː]kael	m[ɪ]kːə
	s[iː]gfrid	s[ɪ]gːə
Δ (ø , ø̝)	j[øː]ran	j[ø̝]rːə

The preceding chart shows full names whose stressed vowel occurs in a stressed open syllable. For familiar phonotactic reasons, this vowel surfaces as long in the full name. Since the vowel precedes a geminate in the nickname template, it surfaces as short in the nickname.

The vowels in the left-hand column and the vowels in the right-hand column differ not only in terms of duration, but also in terms of quality. Linell et al. (1971:39) claims that the long vowels are [+tense], and all of the short vowels [-tense]. Elert (1997:24) states that short vowels tend to be more central. Without pursuing the controversy, I will assume the feature [tense] for concreteness in the following exposition.

So, nicknames feature the following alternating vowel pairs:

(193)

FULL NAME:	NICKNAME:
LONG V	SHORT V
[+TENSE]	[-TENSE]
ɑ	a
ʉ	ɵ
ɛ	ɛ̝
y	ʏ
e	ɛ̝
o	ɔ
u	ʊ
i	ɪ
ø	ø̞

This is an allophonic correspondence; it is not a case of free variation. Tenseness and length are correlated. Associating the tense vowel quality with the short duration is ungrammatical; associating lax quality with the long duration is equally ungrammatical:

(194)

* SHORT V	*LONG V
[+TENSE]	[-TENSE]
*h[ɑ]sːə	*h[aː]ns
*[ɑ]gːə	*[aː]gɵst
*kn[ʉ]tːə	*kn[ɵː]t
*h[ʉ]bːə	*h[ɵː]bert
*p[ɛ]rːa	*p[ɛ̝ː]r
*st[y]bːə	*st[ʏː]rbjørn
*st[e]fːə	*st[ɛ̝ː]fan
*r[o]lːə	*r[ɔː]land

*p[o]lːə	*p[ɔː]l
*[u]lːə	*[ʊː]lof
*b[u]sːə	*b[ʊː]
*m[i]kːə	*m[ɪː]kael
*s[i]gːə	*s[ɪː]gfrid
*j[ø]rːə	*j[ø̞ː]ran

Nicknames provide a clear example, then, of correspondence between vowels that are long and tense with vowels that are short and lax.

4.3.2 A stress-shifting adjective formative suffix–*isk*

Having established correspondence between long and short vowels in the preceding section, let us now establish correspondence in the opposite direction, between short and long vowels. Eliasson 1985 draws attention to systematic correspondences between short and long variants of vowels by comparing unaffixed stems and forms derived by attaching stress-shifting suffixes such as *-isk*. The suffix *-isk* attracts stress to the stem-final syllable; that is, the syllable immediately preceding the suffix. If the stem-final syllable is unstressed in the unsuffixed form, then the vowel will be short in the unsuffixed form. Recall that all unstressed vowels are short. However, since the suffix attracts stress to that stem-final vowel, the vowel (if it is in an open syllable) surfaces as long before *-isk*. Recall that a vowel in a stressed open syllable always surfaces as long. So the stress-shifting suffix can cause a vowel that was short in the unaffixed word to surface as long in the affixed word. The following chart, with data from Eliasson 1985, illustrates the point:

(195)

	UNAFFIXED STEM	STEM + *isk*	
	SHORT V	LONG V	
	[-TENSE]	[+TENSE]	GLOSS (STEM)
Δ (a , ɑ)	ˈalgebr[a]	algeˈbr[ɑː] + isk	'algebra'
	ˈbals[a]m	balˈs[ɑː]m + isk	'balsam'
Δ (ɵ , ʉ)	ˈtalm[ɵ]d	talˈm[ʉː]d + isk	'Talmud'
Δ (ɛ̞ , ɛ)	--	--	
Δ (ʏ , y)	meton[ʏ]ˈm + iː	metoˈn[yː]m + isk	'metonymy'
Δ (ɛ̞ , e)	ˈisra[ɛ̞]l	israˈ [eː]l + isk	'Israel'
Δ (ɔ , o)	ˈeːr[ɔ]s	eˈr[oː]t + isk	'Eros'
Δ (ʊ , uː)	oˈrɑːt[ʊ]r	oraˈt[uː]r + isk	'orator'
Δ (ɪ , i)	pul[ɪ]ˈt + iːk	puˈl[iː]t + isk	'politics'
Δ (øː,ø̞)	--	--	

Setting aside the accidental gaps for two vowels, there is a systematic correspondence between the short vowel of the unaffixed form and the long vowel of the *–isk* form.

Just as the tense and lax vowels pattern allophonically (as opposed to free variation) in nicknames, they pattern allophonically in the paradigms of *–isk* suffixation. If one associates lax quality to the long vowels in the *–isk* paradigm, the result is ungrammatical. Likewise, if one associates tense quality to the short vowels in the unaffixed forms, the result is ungrammatical[32]:

[32] I am simplifying the facts slightly. The vowel [ʉ] can surface as tense and short, if it is in an open syllable. The laxness for that vowel is restricted to closed syllables; see Linell (1973). Formalizing this detail is beyond the scope of the present work, however. Equally interesting, [aː] can surface as lax and long in the word [faːn] 'Satan'. Perhaps the phonotactically marginal quality of this word mirrors its taboo meaning.

(196)	*LONG V	* SHORT V
	[-TENSE]	[+ TENSE]
	*algebr[aː]isk	*algebr[ɑ]
	*bals[aː]misk	*bals[ɑ]m
	*talm[ɵː]d isk	*talm[ʉ]d
	*meton[ʏː]misk	*meton[y]miː
	*isra[ɛ̝ː]lisk	*isra[e]l
	*er[ɔː]tisk	*er[o]s
	*orɑːt[ʊː]risk	*orat[u]r
	*pul[ɪː]tisk	*pul[i]tik

So, tenseness and length are correlated in the paradigms of *–isk* affixation, just as they are in nickname formation.

4.4 Blocked tensing with voiced post-alveolars

4.4.1 Overview

In this section, I discuss the phenomenon of post-alveolar coalescence (Linell et al. 1971, Eliasson & LaPelle 1973, Hellberg 1974, Eliasson 1975, Schmid 1987, Börjars 1988). I introduce the phonotactic of voiced post-alveolars: these post-alveolars are short, and the preceding stressed vowel is long. I provide an Optimality Theoretic formalism (Prince & Smolensky 1993/2004) for this phonologized phonetic effect. I then show some exceptional lexical items, where coalescence is blocked, and the stressed vowel surfaces as short. These are vowels whose tensing would result in a greater perceptual difference than other vowels. I then discuss Zuraw's *MAP proposal, a mechanism that generates OT constraint rankings from perceptual distances.

4.4.2 Background on post-alveolar coalescence

When /r/ is followed by a voiced dental /d, n, l /, the two sounds coalesce into one voiced post-alveolar segment [ɖ, ɳ, ɭ]. As mentioned above, this derived post-alveolar [ɖ, ɳ, ɭ] generally surfaces as short; a preceding vowel is generally long, assuming that it is in a stressed syllable.[33] The following examples illustrate this phonotactic:

(197)

V	UR	SR	*	GLOSS
ɑ	/bɑrd/	[ˈbɑːɖ]	*[ˈbaɖː]	'bard'
ʉ	/ʉrna/	[ˈʉːɳa]	*[ˈɵɳːa]	'urn'
ɛ	/jɛrna/	[ˈjɛːɳa]	*[ˈjɛɳːa]	'with pleasure'
y	--	--	--	--
e	/herde/	[ˈheːɖe]	*[ˈhe̞ɖːe]	'shepherd'
o	/porla/	[ˈpoːɭa]	*[pɔɭːa]	'murmur'
u	/hurn/	[huːɳ]	*[hʊɳː]	'horn'
i	/hird/	[hiːɖ]	*[hɪɖː]	'housecarl'
ø	/børd/	[ˈbøːɖ]	*[ˈbø̞ːɖ]	'lineage, descent'

This phonotactic is part of the phonological system, but it is based on a phonetic tendency of shortening of voiced consonants.

4.4.3 Decreased duration of voiced consonants

Elert (1964:145 ff.) notes that 'that unvoiced consonants are longer than voiced consonants….' He points out that

[33] Recall that unstressed vowels are always short. There are cases where coalescence is blocked, and vowel lengthening does not take place; this is discussed below.

in practically all languages in which consonant duration has been measured, unvoiced consonants are longer than voiced consonants. This is reported to be the case in Czech by N. Chlumsky (1928:xv f.), in Icelandic by Stefán Einarsson (1927: 50,53,57) and Sveinn Bergsveinsson (1941:122 f.), in Italian by Clara Metz (1914:57 f., 108), in French by Marguerite Durand (1936:101) and in Norwegian by Fintoft (1961:29).

However, the durational patterning of Swedish post-alveolars is phonological, rather than merely phonetic. The short duration of derived voiced post-alveolars is categorical, and triggers lengthening and tensing on the preceding stressed vowel. The long duration of derived voiceless post-alveolars is likewise categorical, and triggers shortening and laxing on the preceding stressed vowel. Consider the following contrasting pair:

(198)	UR	SR	*	GLOSS
	/sort/	s[ɔ$_L$]ʈː	*s[oː$_T$]ʈ	'type, sort'
	/vord/	v[oː$_T$]ɖ	*v[ɔ$_L$]ɖː	'care'

Before non-derived sounds, including /t/ and /d/, consonant voicing and vowel tensing are orthogonal. In this case, it is not the voicing of the consonant that determines the tenseness of the vowel; rather, it is the duration of the consonant that sets it. If stressed, a lax vowel precedes a long consonant, independent of its voicing.

(199)	UR	SR	*	GLOSS
	/sodː/	s[ɔ$_L$]dː	*s[o$_T$]dː	'sowed'
	/motː/	m[ɔ$_L$]tː	*m[o$_T$]tː	'measure'

By the same token, a tense vowel precedes a short consonant, independent of its voicing.

(200)	UR	SR	*	GLOSS
	/nod/	n[oː$_T$]d	*n[ɔː$_L$]d	'mercy'
	/vot/	v[oː$_T$]t	*v[ɔː$_L$]t	'wet'

So, a derived voiced post-alveolar is phonologically short; a derived voiceless post-alveolar is phonologically long.

This consonant lengthening is an instantiation of phonologization of phonetic effects (Hayes 1999, Rose 2005). In her study of Endegen gemination and Friulian vowel lengthening, Rose notes that the simplistic division between phonetics/phonology is misguided, as '...non-contrastive segment duration can impact phonological timing structure (gemination, vowel-length)' (Rose 2005:1) and 'the duration of the final consonant impacts gemination' (Rose 2005:5). Further examples of phonetic effects resulting in phonological reflexes have been set forth by Gordon 1999, relating phonetic coda duration to phonological syllable weight; and Zhang 2004, relating phonetic duration of rhyme and phonological licensing of contour tone.

Embracing Rose's insight, assume that the phonology of Swedish features a constraint that rules out a long post-alveolar consonant:

(201) $*C_{\mu}$ / [ɖ ɳ ɭ]

A voiced derived post-alveolar consonant may not be moraic.

This constraint will be central to our analysis of post-alveolar coalescence.

4.4.4 Formalism for regular phonotactic $*C_{\mu}$ / [ɖ ɳ ɭ]

To construct an account of vowel lengthening before voiced post-alveolars in Swedish, we must add some constraints to our arsenal. In addition to the constraint above, we need a constraint to enforce the phonotactics of segment length, as discussed in the Introduction.

(202) $\sigma_{\mu\mu} \leftrightarrow$ [+stress]

A syllable is bimoraic iff it is stressed

Furthermore, since coalescence involves a distortion of URs, there must be some constraint against non-coalesced r+coronal clusters.

(203) *r[+cor]

[r] may not be followed by a coronal segment

As mentioned, Linell et al (1971:39 ff.) noted that tenseness and length are correlated. A biconditional statement of this correlation captures this generalization, and rules out inappropriate correlations:

(204) [+LONG] ↔ [+TENSE]

A vowel is bimoraic if and only if it is tense.

Since this is stated as a biconditional, it also forces short vowels to be lax.

Another relevant constraint involves I-O faithfulness to the feature [tense]:

(205) IDENT [tense]

UR and SR must have the same value for [tense].

The ranking of these constraints is the topic of the following section.

4.4.5 Tableaux and rankings

We will presently generate the vowel lengthening before voiced post-alveolars. However, one question that surfaces involves vowel quality in UR. Should a vowel that surfaces as long and tense be specified as tense in UR? The correct output can be derived with either value of [tense] in UR, given a properly low ranking of IDENT [tense]. First, take the easy case, with a tense vowel in UR.

(206)

/bø$_T$rd/ ‘lineage, descent’	$\sigma_{\mu\mu}$ ↔ [+ stress]	*C_μ / [ɖ ɳ ɭ]	[+ LONG] ↔ [+ TENSE]	*r[+ cor]	IDENT [tense]
a. bø$_T$ːɖː	*!	*			
b. bø$_L$ɖː		*!			
c. bø$_L$ːɖ			*!		
d. bø$_L$rd				*!	
e. > bø$_T$ːɖ					

The biconditional of segment length rules out the trimoraic form of candidate (a). The constraint against short vowels before voiced post-alveolars rules out candidate (b). The biconditional correlating length and tenseness rules out candidate (c), since the vowel is lax and long. The constraint against [r] followed by a coronal rules out (d), since the two coronals are not coalesced. Given a tense vowel in the input, IDENT [tense] is unviolated, so candidate (e) is the optimal candidate.

Now assume a UR with a lax vowel.

(207)

/bø$_L$rd/ ‘lineage, descent’	$\sigma_{\mu\mu}$ ↔ [+stress]	*C_μ / [ɖ ɳ ɭ]	[+LONG] ↔ [+TENSE]	*r[+cor]	IDENT [tense]
a. bø$_T$ːɖːː	*!	*			*
b. bø$_L$ɖːː		*!			
c. bø$_L$ːɖ			*!		
d. bø$_L$rd				*!	
e. > bø$_T$ːɖ					*

Candidates (a) through (d) are ruled out for exactly the same reasons discussed in the previous paragraph. The difference is that candidate (e) now violates IDENT [tense]. However, this does not alter the outcome, assuming that this constraint is ranked lower than the other four. Summarizing, the correct output is independent of tenseness in UR, assuming the following ranking:

(208) $\sigma_{\mu\mu}$ ↔ [+stress]

*C_μ / [ɖ ɳ ɭ]

[+LONG] ↔ [+TENSE]

*r[+cor]

≫ IDENT [TENSE]

4.4.6 Complications with ‘guard’ and ‘Kurd’

The words for ‘guard’ and ‘Kurd’ provide a puzzle, showing that the ranking established above must be revised. Both words lack post-alveolar coalescence, and both words surface with a short vowel, as listed in Hedelin (1997):

(209)

NON-COALESCENCE	EXPECTED FORM	GLOSS
[ˈga$_L$rd]	^{OK}[ˈgɑː$_T$ɖ][34]	'guard'
[ˈkɵ$_L$rd][35]	*[ˈkɐːɖ]	'Kurd'

The constraints and rankings established previously fail to generate the correct output. Just as the word 'birth, lineage' surfaces with a long tense vowel followed by a coalesced post-alveolar, the word 'guard' is predicted to only surface with a long tense vowel followed by a coalesced post-alveolar. The arrow '>' marks the relevant form, with blocked coalescence; the bomb-symbol '💣' marks the predicted output.

(210)

	/ga$_L$rd/ 'guard'	$\sigma_{\mu\mu}$ ↔ [+stress]	*C$_\mu$ / [ɖ,ɳ,ʃ,ʒ]	[+LONG] ↔ [+TENSE]	*r[+cor]	I IDENT [tense]
a.	gɑ$_T$:ɖ:	*!	*			*
b.	ga$_L$ ɖ:		*!			
c.	ga$_L$:ɖ			*!		
d. >	ga$_L$rd				*!	
e. 💣	gɑ$_T$:ɖ					*

The same problem arises for the word for 'Kurd':

[34] Both alternatives are attested. In the discussion below, assume the dialect with blocked correspondence. The dialect difference presumably involves different markings on underlying vowels. So the pronunciations with a long tense vowel are marked with a tense vowel in UR, like the standard pronunciation of 'bard' in example (228) below.

[35] Hedelin 1997 actually lists this as [ˈkɵrɖ]. I assume that the postalveolarized dental is a typo. In any event, the important detail is the short lax vowel, and the lack of coalescence.

(211)

	/kɵ$_L$rd/ ‘Kurd’	$\sigma_{\mu\mu}$ ↔ [+ stress]	*C_μ / [ɖ ɳ ɭ]	[+ LONG] ↔ [+ TENSE]	*r[+ cor]	IDENT [tense]
a.	k~~ʉ~~$_T$:ɖ:	*!	*			*
b.	kɵ$_L$ɖ:		*!			
c.	kɵ$_L$:ɖ			*!		
d. >	kɵ$_L$rd				*!	
e. 💣	k~~ʉ~~$_T$:ɖ					*

One might suggest a ‘cophonologies’ approach to the problem, where different words are given different constraint rankings (Orgun 1996, Inkelas 1998, Anttila 2002). Perhaps certain words of the lexicon feature a diacritic—call it D—such that words marked with D feature the inverted ranking *IDENT [TENSE] ≫*r[cor]. This would generate the correct output for ‘guard’ and ‘Kurd’:

(212)

	/gard/ ‘guard’	$\sigma_{\mu\mu}$ ↔ [+stress]	*C_{μ} / [ɖ ɳ ɭ]	[+LONG] ↔ [+TENSE]	IDENT [tense]	*r[+cor]
a.	$gɑ:_{T}ɖ.:$	*!	*		*	
b.	$ga_{L}ɖ:$		*!			
c.	$gɑ:_{L}ɖ.$			*!		
d. >	$ga_{L}rd$					*
e.	$gɑ:_{T}ɖ.$				*!	

(213)

	/$kɵ_{L}rd$/ ‘Kurd’	$\sigma_{\mu\mu}$ ↔ [+stress]	*C_{μ} / [ɖ ɳ ɭ]	[+LONG] ↔ [+TENSE]	IDENT [tense]	*r[+cor]
a.	$k\cancel{ʉ}_{T}:ɖ:$	*!	*		*	
b.	$kɵ_{L}ɖ:$		*!			
c.	$kɵ_{L}:ɖ.$			*!		
d. >	$kɵ_{L}rd$					*
e.	$k\cancel{ʉ}_{T}:ɖ.$				*!	

Resorting to a diacritic in this way is explanatorily inadequate. It fails to address a deeper question, of why the words ‘guard’ and ‘Kurd’ pattern differently; or, to rephrase the question, why they are marked with the diacritic. Also, the diacritic account fails to capture a generalization: only words featuring the vowels [a, ɵ] can

block coalescence of voiced post-alveolars. Blocked coalescence is either standard or optional in the following words[36]:

(214)

VOWEL	NON-COALESCENCE	EXPECTED FORM	GLOSS
[a]	[ˈga$_L$rd]	^{OK}[ˈgɑː$_T$d̪]	‘guard’
[a]	[mɪlˈja$_L$rd]	^{OK}[mɪlˈjɑː$_T$d̪][37]	‘billion’
[ɵ]	[ˈɵ$_L$rdʉ][38]	*[ˈʉː$_T$d̪ʉ]	‘Urdu’
[ɵ]	[apˈsɵ$_L$rd]	*[apˈsʉː$_T$d̪]	‘absurd’
[ɵ]	[ˈkɵ$_L$rd]	*[ˈkʉː$_T$d̪]	‘Kurd’

As far as I know, blocked coalescence is unattested with other vowels. The following chart shows words which feature coalesced coronals after the other vowels, modulo one accidental gap:

[36] Linell (1978:128) describes a dialect where the relevant lax vowel is long, before a short coalesced voiced postalveolar. He lists the words orthographically, *urdu* ‘Urdu’, *kurd* ‘Kurd’, *absurd* ‘absurd’, *biljard* ‘billiards’, *boulevard* ‘boulevard’. This dialect would require some changes in the present constraint set, but the underlying phenomenon is the same: the lax vowels [a, ɵ] resist correspondence with the expected tense counterparts. The point remains that correspondence is sensitive to perceptual distance.

[37] I have also heard blocked coalescence in the words [bɪlˈja$_L$rd] ‘billiards’ and [bʊləˈva$_L$rd] ‘boulevard’. However, Hedelin 1997 lists these words only with a long tense vowel followed by a short coalesced postalveolar.

[38] Again, Hedelin 1997 is inconsistent about the stop. The word is transcribed as [ˈɵrd̪ʉ]. The important detail is the lax vowel and the blocked coalescence.

(215)

V	UR	SR	*	GLOSS
ɛ	/jɛrna/	[ˈjɛːɳa]	*[ˈjɛ̝rna]	'with pleasure'
y	--	--	--	--
e	/herde/	[ˈheːɖe̞]	*[ˈhe̞rde]	'shepherd'
o	/porl/	[poːl̩]	*[pɔrl]	'murmur'
u	/hurn/	[huːɳ̩]	*[hʊrn]	'horn'
i	/hird/	[hiːɖ̩]	*[hɪrd]	'housecarl'
ø	/børda/	[ˈbøːɖa̞]	*[ˈbø̞rda]	'burden'

It appears, then, that the IDENT [tense] constraint patterns differently for the vowels [a, ɵ] than for other vowels. In particular, IDENT [tense]/a and IDENT [tense]/ɵ seem to be ranked higher than *r[+cor], whereas IDENT [tense] for the other vowels appears to be ranked lower than *r[+cor].

(216)

IDENT [tense] /a

IDENT [tense] /ɵ

≫ *r[+cor]

≫ IDENT [tense] /ɛ

IDENT [tense] /y

IDENT [tense] /e

IDENT [tense] /o

IDENT [tense] /u

IDENT [tense] /i

IDENT [tense] /ø

However, just as we criticized the diacritic approach to the blocked coalescence in 'guard' and 'Kurd' for being *ad hoc*, the astute reader might criticize the scale presented above, on the same grounds. If we have no independent reason as to why the vowels [a,

ɵ] should pattern differently than other vowels, we are merely engaging in gratuitous stipulation.

4.4.7 Perceptual distance between long and short allophones

The vowels [a] and [ɵ] pattern differently from other vowels because these vowels feature the greatest perceptual distance between their short lax variant and their long tense variant. That is, the distance between lax [a] and tense [ɑ] and the distance between lax [ɵ] and tense [ʉ] are greater than the distance between other lax vowels and their alternating tense vowel.

Elert notes the articulatory differences between the pairs [a_L $ɑ_T$] and [$ɵ_L$ $ʉ_T$]. He places [a] in the low central region of the vowel chart (Elert 1979:36), whereas [ɑ] is low back. Furthermore, the vowel [ɑ] is 'somewhat rounded' (Elert 1997:17)[39], while [a] is not rounded. Elert (1979:36) notes that

> In contemporary Swedish, the long *u*-vowel ([ʉː]) …is a front vowel, which in the vowel chart can be placed very close to [e]. The long Swedish *u*-sound ([ʉː]) is however hyperround, even more rounded than the long *ö*-sound ([øː]). The short *u*-sound ([ɵ])…is a rounded…mid high central vowel.[40]

So the vowels [$ɵ_L$ $ʉ_T$] differ in frontness and hyperrounding. Furthermore, Elert (1979:37) notes that [ʉ] is often diphthongized, with a [β] offglide. Short [ɵ] is never diphthongized.

---

[39] The translation is mine [-IL]. The original reads 'något rundad'.

[40] The translation is mine [-IL]. The original reads 'I nusvenskan är långt *u*… en främre vokal, som i vokalfyrsidingen kan inplaceras helt nära [e]. Det långa svenska *u*-ljudet är emellertid överrundat, än mer rundat än långt *ö*-ljud. Det korta *u*-ljudet…är en rundad…halvsluten mellanvokal.' In the original text, the vowels are referred to by their orthographic symbols. I have added the appropriate IPA symbols.

The perceptual distance between the pairs [a_L $ɑ_T$] and [$ɵ_L$ $ʉ_T$] is frequently noted in the Swedish phonetic and phonological literature. Linell (1978:128) notes that

> [d]ifferences in vowel length are accompanied by often considerable qualitative differences. These differences are so great that they cannot be explained as mechanical consequences of the differences in duration (true of most vowels but particularly of a̲ ([ɑː] vs. [a]) and ʉ̲ ([ʉː] vs. [ɵ])).[41]

Likewise, Fant (1973:33) notes that even untrained speakers of Swedish are aware of this difference in quality:

> It is not very hard to make an untrained subject aware of a difference inherent sound quality of a sustained [ɑː] compared to [a] or [oː] compared to [ɔ] or [ʉː] compared to [ɵ]. In all other pairs of long and short vowels the quality difference is rather small, and it is doubtful whether there is any difference between [ɛː] and [ɛ] or between [øː] and [ø]. [42]

Hadding-Koch and Abramson (1964) establish that the cue for distinguishing short [ɵ] and long [ʉː] was primarily quality, not duration. The opposite held true for the pairs [ɛ̝, ɛː] and [ø̝, øː]; for these vowels, duration was the main cue. The pairs [vɛːg] / [vɛ̝gː] and [støːta] / [stø̝tːa] where distinguished by means of the length cue; however, for [fʉːl] / [fɵlː], duration was not such an important cue. Here, quality rather than duration was the significant cue.

Thorén (2008:66ff.) similarly shows that vowel pairs differ as to their sensitivity to duration manipulation. He considered six vowel pairs, in the following near-minimal pairs:

---

[41] In the original, the author refers to the vowel [ʉ] with the symbol [ɯ].
[42] In the original text, the vowels are referred to by their orthographic symbols with arbitrary numerical subscripts. I altered this for transparency.

(217)	[hʉːt] ‘manners’	[hɵtː] ‘snifter’
	[mɑːt] ‘food’	[matː] ‘faint’
	[søːt] ‘sweet, non-n.’	[sø̞tː] ‘sweet, n.’
	[tɛːt] ‘tight, close; non-n.’	[tɛ̞tː] ‘tight, close; n.’
	[viːt] ‘white, non-n.’	[vɪtː] ‘white, n.’
	[voːt] ‘wet, non-n.’	[vɔtː] ‘wet, n.’

The VːC words were manipulated by PRAAT (Boersma & Weeninck 2001), such that the vowel was gradually shortened, and the C gradually lengthened, to eventually have the durational properties of a VCː word. Similarly, the VCː words were manipulated in the opposite gradual manner, so that the vowel was lengthened and the Cː shortened, such that the word eventually had the durational aspect of a VːC word. All six vowels could be misperceived as its durationally distinct counterpart, but they differed in how much manipulation was required to trigger this effect. The pair [ʉː, ɵ] required the greatest change in duration to trigger a perceptual shift; the pair [ɛː, ɛ̞] required the smallest change in duration to trigger a perceptual shift. The scale among the vowels—from the vowel pair requiring the least duration manipulation to the vowel pair needing the most manipulation—was as follows (Thorén 2008:75):

[ɛː, ɛ̞] , [øː, ø̞] >> [oː, ɔ] >> [iː, ɪ], [ɑː, a] >> [ʉː, ɵ]. Note that [ɑː, a] and [ʉː, ɵ] were on the extreme end of the scale, in requiring extreme duration manipulations to trigger recategorization.[43]

So, there is good reason to assume that there is a substantial perceptual distance between lax [a] and tense [ɑ] as well as between lax [ɵ] and tense [ʉ]. If the grammar

[43] I find the high ranking of [i, ɪ] surprising. It is unclear to me why it would trigger as strong an effect as [ɑ, a].

refers to perceptual distance between vowel allophones, the puzzle of the outputs for ‘guard’ and ‘Kurd’ is solved.

4.4.8 A mechanism to formalize the pattern

Kuronen (2000:128) provides average formant frequencies in Hz of both long and short Swedish vowels.

(218)

	F1	F2	F3
$ɑ_T$	523	859	2480
a_L	701	1342	2439
$ʉ_T$	328	1733	2453
$ɵ_L$	411	1223	2493
$ɛ_T$	590	1650	2711
$ɛ̞_L$	451	1945	2816
y_T	285	2258	2994
$ʏ_L$	364	1919	2697
e_T	385	2194	2920
$ɛ_L$	451	1945	2816
o_T	388	711	2741
$ɔ_L$	453	834	2628

u_T	299	678	2707
$ʊ_L$	350	763	2634
i_T	275	2363	3304
$ɪ_L$	332	2241	3000
$ø_T$	491	1439	2506
$ø_L$	492	1332	2519

With these formant values, it is possible to establish the location of the vowels in a two-dimensional space, and then calculate the perceptual distance between them. The vowel space can be plotted on axes F1 and F2′. Paliwal et al (1983:301) provides the following equation to compute F2′ from F1, F2, and F3.

(219) $$F2' = F2 + D1F1/(F2-F1) + D2F3/(F3-F2)$$

In this equation, D1 = 164.9 and D2 = 33.3. By transforming the formant values into Bark, and weighting F2′ at 0.3, as is standard (Vallée 1994; Schwartz, Boë, Vallée and Abry 1997; De Boer 2001), one obtains the following scale of perceptual distances between long tense vowels and short lax vowels. The vowel pairs are listed in order of decreasing perceptual distance.[44]

(220)		$\Delta\ \{ɑ_T, a_L\}$	1.77
	>	$\Delta\ \{ʉ_T, ɵ_L\}$	1.37[45]
	>	$\Delta\ \{ɛ_T, ɛ_L\}$	1.28[46]

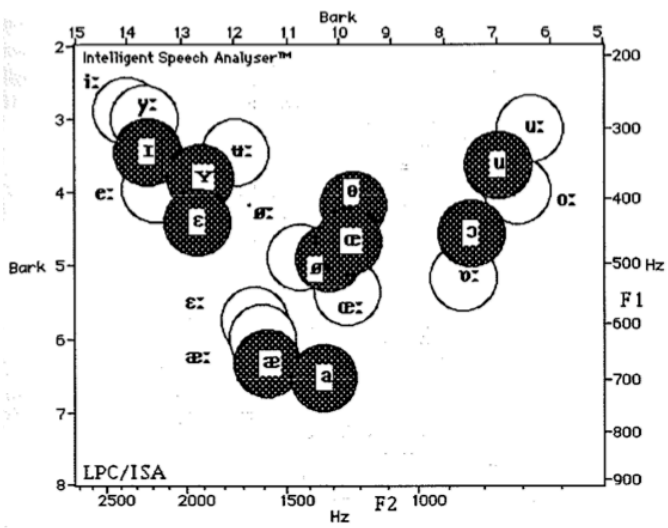
[44] An attempt at establishing these scales perceptually is discussed in section 6.10 and 6.11.

[45] I suspect that the true value for $\Delta\ \{ʉ_T, ɵ_L\}$ is higher than that of $\Delta\ \{ɑ_T, a_L\}$ for most speakers. In any event, these two vowel pairs are the most distant in the language.

>	Δ {y_T,$ʏ_L$}	0.95
>	Δ {e_T,$ɛ_L$}	0.74
>	Δ {o_T,$ɔ_L$}	0.71
>	Δ {u_T,$ʊ_L$}	0.59
>	Δ {i_T,$ɪ_L$}	0.58
>	Δ {$ø_T$,$ø̞_L$}	0.23

The specific number associated with each pair is irrelevant for present purposes; what matters is merely their relative value with respect to each other. The relative distances between tense and lax counterparts can be seen graphically on the following chart from Kuronen (2000:119):

(221)



The symbol [ɒ] corresponds to the vowel we have referred to as [ɑ]. The symbols [æ,œ] are allophones that result from r-coloring, irrelevant to the present thesis.

[46] The high value assigned to this vowel distance is surprising; these vowels are certainly not nearly as distant as Δ {$ʉ_T$,$ɵ_L$}.

A formalism for relating perceptual distances and correspondence relations is found in Zuraw's *MAP. Zuraw's *MAP constraint rules out correspondences:

(222) ***MAP S_1S_2 ($^{A}X^{B}$, $^{C}Y^{D}$)** (Zuraw 2007)

an X in the environment A_B in string S_1 must not correspond to a Y in the environment C_D in string S_2.

Perceptual distance between alternants determines the relative ranking of the *MAP constraint:

(223) **Distance-to-ranking projection** (Zuraw p.c.)[47]

If $\Delta(^{A}X^{B}, {}^{C}Y^{D}) > \Delta(^{A'}X'^{B'}, {}^{C'}Y'^{D'})$

then *MAP S_1S_2 ($^{A}X^{B}$, $^{C}Y^{D}$) $\gg$ *MAP S_1S_2 ($^{A'}X'^{B'}$, $^{C'}Y'^{D'}$)

If alternants X and Y are perceptually more distant than X′ and Y′, then the correspondence between X and Y is more severely penalized than correspondence between X′ and Y′.[48]

Zuraw's distance-to-ranking projection mechanism generates the following constraint rankings:

(224)

	LAX-TO-TENSE		TENSE-TO-LAX
	*MAP (a_L, $ɑ_T$)		*MAP ($ɑ_T$, a_L)
$\gg$	*MAP ($ɵ_L$, $ʉ_T$)	$\gg$	*MAP ($ʉ_T$, $ɵ_L$)
$\gg$	*MAP ($ɛ̝_L$, $ɛ_T$)	$\gg$	*MAP ($ɛ_T$, $ɛ̝_L$)
$\gg$	*MAP ($ʏ_L$, y_T)	$\gg$	*MAP (y_T ,$ʏ_L$)
$\gg$	*MAP ($ɛ_L$, e_T)	$\gg$	*MAP (e_T , $ɛ_L$)
$\gg$	*MAP ($ɔ_L$, o_T)	$\gg$	*MAP (o_T , $ɔ_L$)
$\gg$	*MAP ($ʊ_L$, u_T)	$\gg$	*MAP (u_T , $ʊ_L$)

[47] For similar proposals, see Fleischhacker 2005, Kawahara 2006, and Wilson 2006.
[48] I will abstract away from environmental indices in my account, since they are not relevant to the issues being discussed.

≫ *MAP ($ɪ_L$, i_T) ≫ *MAP (i_T ,$ɪ_L$)

≫ *MAP ($ø_L$, $ø_T$) ≫ *MAP ($ø_T$, $ø_L$)

By interleaving *r[+cor] in the first ranking in (224), the following scale is obtained:

(225) *MAP (a_L, $ɑ_T$)

≫ *MAP ($ɵ_L$, $ʉ_T$)

≫ *r[+cor] ← interleaved.

≫ *MAP ($ɛ̝_L$, $ɛ_T$)

≫ *MAP ($ʏ_L$, y_T)

≫ *MAP ($ɛ_L$, e_T)

≫ *MAP ($ɔ_L$, o_T)

≫ *MAP ($ʊ_L$, u_T)

≫ *MAP ($ɪ_L$, i_T)

≫ *MAP ($ø̞_L$, $ø_T$)

Now consider the tableaux for 'guard', to see how the blocked coalescence is generated:

(226)

	/ga_Lrd/ 'guard'	$\sigma_{\mu\mu}$ ↔ [+stress]	*C_μ / [ɖ ɳ ɭ ʈ]	[+LONG] ↔ [+TENSE]	*MAP (a_L, $ɑ_T$)	*MAP ($ɵ_L$, $ʉ_T$)	*r[+cor]	*MAP ($ø̞_L$, $ø_T$)
a.	$gɑː_T$ɖː	*!			*			
b.	ga_Lɖː		*!					
c.	$gaː_L$ɖ			*!				
d. >	ga_Lrd						*	
e.	$gɑː_T$ɖ				*!			

Candidates (a), (b) and (c) are ruled out by phonotactic constraints discussed above. Consider candidates (d) and (e). Different vowels have different rankings of *MAP, and *MAP (a_L, $ɑ_T$) is ranked highest, for the reasons just discussed. Crucially, it is ranked higher than *r[+cor]. For this reason, candidate (e), with an unfaithful tense vowel, is dispreferred. Candidate (d), without coalescence, emerges as the optimal candidate.

The tableau for 'Kurd' works in a similar fashion.

In contrast to *MAP (a_L, $ɑ_T$) and *MAP ($ɵ_L$, $ʉ_T$), *MAP ($ø̞_L$, $ø_T$) is ranked lower than *r[+cor]. For this reason, the candidate with blocked coalescence—candidate (d)—is no longer optimal. The candidate with altered tenseness emerges as the optimal candidate.

(227)

	/bø$_L$rd/ 'lineage, descent'	$\sigma_{\mu\mu}$ ↔ [+stress]	*C_μ / [ɖ ɳ ɭ ʈ]	[+LONG]↔ [+TENSE]	*MAP (a_L, $ɑ_T$)	*MAP ($ɵ_L$, $ʉ_T$)	*r[+cor]	*MAP ($ø̞_L$, $ø_T$)
a.	bø$_T$:ɖ:	*!						*
b.	bø$_L$ɖ:		*!					
c.	bø$_L$:ɖ			*!				
d.	bø$_L$rd						*!	
e. >	bø$_T$:ɖ							*

The remaining vowels pattern like [ø], with the relevant *MAP constraint ranked lower than *r[+cor].

There are also words with the tense [ɑ] or [ʉ] followed by coalesced voiced post-alveolars. For example, chart (197) above included [ˈbɑː$_T$ɖ] 'bard', with a long tense low vowel and a coalesced post-alveolar, and some dialects pronounce 'guard' with a long

tense vowel before a short coalesced post-alveolar. I assume that in such cases, the vowel is marked as tense in UR, e.g., /bɑ$_T$rd/, so there is no violation of *MAP in this output.

(228)

	/bɑ$_T$rd/ ‘bard’	$\sigma_{\mu\mu}$ ↔ [+stress]	*C$_\mu$ / [ɖ, ɳ, ɭ]	[+LONG] ↔ [+TENSE]	*MAP (ɑ$_T$, a$_L$)	*r[+cor]
a.	bɑː$_T$ɖ̩ː	*!				
b.	ba$_L$ɖ̩ː		*!		*	
c.	baː$_L$ɖ̩			*!	*	
d.	ba$_L$rd				*!	*
e. >	bɑː$_T$ɖ̩					

4.5 Blocked laxing with voiceless post-alveolars

4.5.1 Data

Just as the mapping [a$_L$] → [ɑ$_T$] results in exceptional phonotactic patterns before the cluster [rd], the reversed mapping [ɑ$_T$] → [a$_L$] results in exceptional phonotactic patterns before the derived post-alveolar segments [ʂ] and [ʈ].

The clusters [rs] and [rt] generally coalesce into voiceless post-alveolar segments [ʂ] and [ʈ], respectively. In stressed syllables, these post-alveolars are long; the preceding stressed vowel is short. The following chart illustrates the pattern:

(229)

UR	SR	*	GLOSS
/fars/	[faʂː]	*[fɑːʂ]	‘farce’
/fors/	[fɔʂː]	*[foːʂ]	‘rapids’

/børs/	[bø̞ʂː]	*[bøːʂ]	‘stock exchange’
/kørt/	[kø̞ʈː]	*[kʉːʈ]	‘Kurt, a name’
/myrten/	[ˈmʏʈːən]	*[ˈmyːʈən]	‘myrtle’
/jɛrta/	[ˈjɛ̞ʈːa]	*[ˈjɛːʈa]	‘heart’
/lurt/	[lʊʈː]	*[luːʈ]	‘filth’

The prohibition against short voiceless post-alveolars may be stated using the following constraint:

(230) *C-μ / [ʂ, ʈ]

A voiceless derived post-alveolar consonant must be moraic.

Since the vowel always surfaces as short and lax, it is not obvious whether the UR is lax or tense: by Richness of the Base (Prince & Smolensky 1993/2004), we must consider both possibilities. The following tableau illustrates how a lax vowel in UR surfaces faithfully:

(231)

	/fɔ$_L$rs/ ‘rapids’	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	*r[+cor]	*C-μ / [ʂ, ʈ]	*MAP (o_T, $ɔ_L$)
a.	fo$_T$ːʂː	*!				
b.	fo$_T$ʂː		*!			
c.	fɔ$_L$rs			*!		
d.	fo$_T$ːʂ				*!	
e. >	fɔ$_L$ʂː					

If, on the other hand, the vowel is tense in UR, we must assume that *C-μ/[ʂ, ʈ] ≫ *MAP ($ɔ_L$, o_T), to ensure that the unfaithful mapping of the vowel emerges as the optimal candidate.

(232)

	/fo_Trs/ 'rapids'	$σ_{μμ}$ ↔ [+stress]	[+LONG]↔ [+TENSE]	*r[+cor]	*C-μ / [ʂ, ʈ]	*MAP (o_T, $ɔ_L$)
a.	fo_T:ʂ:	*!				
b.	fo_Tʂ:		*!			
c.	$fɔ_L$rs			*!		*
d.	fo_T:ʂ				*!	
e. >	$fɔ_L$ʂ:					*

4.5.2 Exceptional vowel length before [ʂ, ʈ]

Not all vowels pattern like the pair [o_T , $ɔ_L$] above. There are some words where the constraint *C-μ/ [ʂ, ʈ] is violated, and the *MAP constraint is obeyed. The result is that the derived post-alveolars [ʂ, ʈ] surface as short, and the preceding stressed vowel is long. Consider the following examples from Hedelin 1997:

(233)

*CORRESP.	UR	SR	*	GLOSS
*ɑ → a	/lɑrs/	[ˈlɑːʂ]	*[ˈlaʂː]	'Lars, a name'
*ɑ → a	/ɑrt/	[ˈɑːʈ]	*[ˈaʈː]	'kind, sort'
*ɑ → a	/smart/	[ˈsmɑːʈ]	*[ˈsmaʈː]	'smart'

*ɑ → a	/fɑrt/	[ˈfɑːt̪]	OK[ˈfat̪ː][49]	‘speed’
*ɑ → a	/ɑrta/	[ˈɑːt̪a]	*[ˈat̪ːa]	‘to shape’
*ɑ → a	/kɑrta/	[ˈkɑːt̪a]	*[ˈkat̪ːa]	‘map’

Recall that we established above that *$C_{-\mu}$/ [ʂ, t̪] ≫ *MAP ($ɔ_L$, o_T). If we naively assumed that all vowels had the same *MAP constraint for the lax-to-tense mapping, this would imply that *$C_{-\mu}$/ [ʂ, t̪] ≫ *MAP (a_L, $ɑ_T$); but this generates the wrong output:

(234)

	/l$ɑ_T$rs/ ‘Lars’	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	*r[+cor]	*C-μ / [ʂ, t̪]	*MAP ($ɑ_T$, a_L)
a.	l$ɑ_T$ːʂː	*!				
b.	l$ɑ_T$ʂː		*!			
c.	l$a_L$rs			*!		*
d. >	l$ɑ_T$ːʂ				*!	
e. 💣	la_Lʂː					*

Just as blocked coalescence of voiced post-alveolars provides evidence for distinct *MAP constraints for different vowel pairs, blocked vowel shortening provides evidence for the same.

Note that all of the exceptional cases in this section involve the vowel [ɑ]. As far as I know, there are no exceptional forms with the rime [ʉːʂ] or [ʉːt̪]. I will assume that this is an accident, to maximize parallelism with exceptional blocked coalescence, discussed in the preceding chapter.

[49] Hedelin 1997 describes this pronunciation as ‘med dialektal prägel’; that is ‘with dialectal stamp’, suggesting that it is a non-standard alternative.

4.5.3 *MAP with an interleaved constraint

Recall the *MAP projection mechanism, as applied to the mapping from tense to lax vowels, which was discussed above:

(235) = (224) *MAP ($ɑ_T$, a_L)

≫ *MAP ($ʉ_T$, $ɵ_L$)

≫ *MAP ($ɛ_T$, $ɛ̞_L$)

≫ *MAP (y_T , $ʏ_L$)

≫ *MAP (e_T , $ɛ_L$)

≫ *MAP (o_T , $ɔ_L$)

≫ *MAP (u_T , $ʊ_L$)

≫ *MAP (i_T , $ɪ_L$)

≫ *MAP ($ø_T$, $ø_L$)

If we interleave *$C_{-\mu}$/ [ʂ, ʈ], such that it is ranked lower than *MAP ($ɑ_T$, a_L) and *MAP ($ʉ_T$, $ɵ_L$), we obtain the following ranking:

(236) *MAP ($ɑ_T$, a_L)

≫ *MAP ($ʉ_T$, $ɵ_L$)

≫ *$C_{-\mu}$/ [ʂ, ʈ] ← interleaved.

≫ *MAP ($ɛ_T$, $ɛ̞_L$) and all other vowel pairs

This ranking provides the correct output for the name 'Lars'—which surfaces with a long tense vowel.

(237)

	/lɑ$_{T}$rs/ ‘Lars’, a name	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	*r[+cor]	*MAP (ɑ$_{T}$, a$_{L}$)	*C-μ / [ʂ, ʈ]	*MAP (o$_{T}$, ɔ$_{L}$)
a.	lɑ$_{T}$:ʂ:	*!					
b.	lɑ$_{T}$ʂ:		*!				
c.	la$_{L}$rs			*!	*		
d. >	lɑ$_{T}$:ʂ					*	
e.	la$_{L}$ʂ:				*!		

The ranking also generates the correct output for the other vowels, which surface with a short vowel, as the following tableau for ‘rapids’ illustrates:

(238)

	/fo$_{T}$rs/ ‘rapids’	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	*r[+cor]	*MAP (ɑ$_{T}$, a$_{L}$)	*C-μ / [ʂ, ʈ]	*MAP (o$_{T}$, ɔ$_{L}$)
a.	fo$_{T}$:ʂ:	*!					
b.	fo$_{T}$ʂ:		*!				
c.	fɔ$_{L}$rs			*!			*
d. >	fo$_{T}$:ʂ					*!	
e.	fo$_{L}$ʂ:						*

Other items with short vowels before a long voiceless post-alveolar are generated in a similar fashion.

Not all low vowels before voiceless post-alveolars are long and tense. The word ‘farce’ [faʂː] surfaces with a short lax vowel before a long post-alveolar. I assume that the vowel is marked as lax in UR in such items, and surfaces faithfully.

(239)

/fa$_L$rs/ ‘farce’	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	*r[+cor]	*MAP (a_T, a_L)	*C-μ / [ʂ, ʈ]	*MAP (o_T, $ɔ_L$)
a. fɑ$_T$ːʂː	*!				*	
b. fɑ$_T$ʂː		*!			*	
c. fa$_L$rs			*!			
d. fɑ$_T$ːʂ					*!	
e. > fa$_L$ʂː						

4.6 Blocked laxing before geminate suffixes: verbs

4.6.1 Third conjugation: C_0V stems

Verbal paradigms feature geminate-initial suffixes, as discussed in Chapter 3. In particular, the supine, participle, and preterite suffixes are geminate-initial (Teleman 1969). A preceding vowel is shortened before such a geminate-initial suffix. The result is that the long tense vowel in the (unaffixed) infinitive alternates with the short lax vowel in the affixed supine, participle, and preterite. Consider some examples:

(240)

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
ˈgn[uː$_T$]	ˈgn[ʊ$_L$]tː	ˈgn[ʊ$_L$]dː	ˈgn[ʊ$_L$]dːə	‘rub’
ˈfl[oː$_T$]	ˈfl[ɔ$_L$]tː	ˈfl[ɔ$_L$]dː	ˈfl[ɔ$_L$]dːə	‘flay’
ˈfl[yː$_T$]	ˈfl[ʏ$_L$]tː	ˈfl[ʏ$_L$]dː	ˈfl[ʏ$_L$]dːə	‘flee’

Recall that the vowel pairs [ɑ$_T$, a$_L$] and [ʉ$_T$, ɵ$_L$] are the vowels whose tense/lax pairs are perceptually most distant from each other. Interestingly, these vowel pairs are underrepresented among these verbs featuring tense/lax correspondence. The following chart illustrates the distribution of regular verbs of the third conjugation; i.e., verbs of the form C_0V, grouped by vowel:[50]

(241)

CORRESP.	#ATTESTED	STEM	SUP	GLOSS
ɑ$_T$ → a$_L$	0 (PREDICTED)	--	--	--
ʉ$_T$ → ɵ$_L$	0 (PREDICTED)	--	--	--
ɛ$_T$ → ɛ̝$_L$	3	kl[ɛː]	kl[ɛ̝]tː	‘clothe’
y$_T$ → ʏ$_L$	8	ˈbr[yː]	ˈbr[ʏ]tː	‘care’
e$_T$ → ɛ	4	ˈɦ[eː]	ˈɦ[ɛ̝]tː	‘occur’
o$_T$ → ɔ$_L$	11	ˈfl[oː]	ˈfl[ɔ]tː	‘flay’
u$_T$ → ʊ$_L$	9	ˈgn[uː]	ˈgn[ʊ]tː	‘rub’
i$_T$ → ɪ$_L$	0	--	--	--
ø$_T$ → ø$_L$	2	ˈstr[øː]	ˈstr[ø̞]tː	‘sprinkle’

The vowels [ɑ$_T$ a$_L$] and [ʉ$_T$ ɵ$_L$] are not represented among these verbs.

[50] For a complete list, see appendix 1.

4.6.2 Exceptional C_0V stems

There are also some exceptional verbs of the form C_0V[51]. These form the participle and preterite by ablaut, but the supine is still formed by means of a geminate suffix. The vowel correspondence [$ʉ_T$, $ɵ_L$] is not attested in this group. The vowel correspondence [$ɑ_T$, a_L] is not attested among these words in standard Swedish.$C_0ɑ$ stems tend to have irregular morphology in standard Swedish. Consider the supine, participle, and preterite forms of the verbs 'take' and 'pull':

(242)

INFINITIVE	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[tɑː]	[tɑːgit]	[tɑːgən]	[tuːg]	'take'
	?[tatː]	*[tadː]	*[tadːə]	
[drɑː]	[drɑːgit]	[drɑːgən]	[druːg]	'pull'
	?[dratː]	*[dradː]	*[dradːə]	

In the paradigms for standard Swedish, there is no [$ɑ_T$, a_L] correspondence. However, note that the supine forms for 'take' and 'pull'are marked with '?'. These non-standard forms are heard in colloquial Swedish (*SAG* 1999:571). To err on the side of caution, I will therefore count these as two cases as featuring [$ɑ_T$, a_L] when I provide a statistical analysis of vowel distribution in tenseness-shifting paradigms below.

Also, the word [hɑː] 'have' is irregular. This word forms its supine by an irregular process (it is [haft]), but it has [$ɑ_T$, a_L] correspondence in the preterite [hadːə].

(243)

INFINITIVE	PRETERITE	GLOSS
[hɑː]	[hadːə]	'have'

So, the vowel correspondence [$ɑ_T$, a_L] are attested in one standard word; it is also attested in two non-standard colloquial forms, resulting in the total of 3 forms.[52]

---

[51] Grammars differ as to whether these should be regarded as third conjugation. Holmes & Hinchliffe (2003) think so, but *SAG* (1999) does not.
[52] For a complete list, see appendix 2.

(244)

CORRESP.	#ATTESTED	STEM	SUPINE	GLOSS
$ɑ_T \rightarrow a_L$	3	--	--	--
$ʉ_T \rightarrow ɵ_L$	0 (PREDICTED)	--	--	--
$ɛ_T \rightarrow ɛ̝_L$	0	--	--	--
$y_T \rightarrow ʏ_L$	0	--	--	--
$e_T \rightarrow ɛ̝_L$	4	b[eː]	b[ɛ̝]tː	'pray'
$o_T \rightarrow ɔ_L$	4	f[oː]	f[ɔ]tː	'get'
$u_T \rightarrow ʊ_L$	0	--	--	--
$i_T \rightarrow ɪ_L$	1	--	--	--
$ø_T \rightarrow ø̝_L$	1	d[øː]	d[ø̝]tː	'die'

4.6.3 Second conjugation: C_0Vd and C_0Vt stems

The vowels in verbal stems of the form C_0Vd and C_0Vt undergo tense/lax alternation when the stem associates with a geminate-initial suffix. The following illustrate stems of the form C_0Vd.

(245)

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
be^{l}t[$yː_T$]da	be^{l}t[$ʏ_L$]tː	be^{l}t[$ʏ_L$]dː	be^{l}t[$ʏ_L$]dːə	'mean'
^{l}f[$øː_T$]da	^{l}f[$ø̝_L$]tː	^{l}f[$ø̝_L$]dː	^{l}f[$ø̝_L$]dːə	'give birth'

The following chart shows the same mapping among verbal stems of the form C_0Vt.

(246)

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
ˈm[ɛː$_T$]ta	ˈm[ɛ̝ $_L$]tː	ˈm[ɛ̝$_L$]tː	ˈm[ɛ̝$_L$]tːə	‘measure’
ˈb[yː$_T$]ta	ˈb[ʏ$_L$]tː	ˈb[ʏ$_L$]tː	ˈb[ʏ$_L$]tːə	‘exchange’
ˈɧ[øː$_T$]ta	ˈɧ[ø̝$_L$]tː	ˈɧ[ø̝$_L$]tː	ˈɧ[ø̝$_L$]tːə	‘care for’

The verbal paradigms show a dispreference of alternation in the vowel pairs [ɑ$_T$, a$_L$] and [ʉ$_T$, ɵ$_L$]. The following chart shows the distribution of regular words of the form C_0Vd (in the ‘second conjugation’) organized by vowel:[53]

(247)

CORRESP.	#ATTESTED	INFINITIVE	SUPINE	GLOSS
ɑ$_T$ → a$_L$	0 (PREDICTED)	--	--	--
ʉ$_T$ → ɵ$_L$	0 (PREDICTED)	--	--	--
ɛ$_T$ → ɛ̝$_L$	0	--	--	--
y$_T$ → ʏ$_L$	4	beˈt[yː]da	beˈt[ʏ]tː	‘meet’
e$_T$ → ɛ	1	ˈl[eː]da	ˈl[ɛ̝]tː	‘lead’
o$_T$ → ɔ$_L$	0	--	--	--
u$_T$ → ʊ$_L$	0	--	--	--
i$_T$ → ɪ$_L$	0	--	--	--
ø$_T$ → ø$_L$	2	ˈf[øː]da	ˈf[ø]tː	‘give birth’

No words featuring the alternating vowels [ɑ$_T$ a$_L$] and [ʉ$_T$ ɵ$_L$] are attested.

This is not due to a lack of stems of the form C_0ɑd or C_0ʉd. Stems of the form C_0ɑd are quite abundant, but they tend to be part of the first conjugation, which features a thematic vowel interleaved between the stem’s dental consonant and the suffix’s dental consonant. Here is an example:

[53] For a complete list, see appendix 3.

(248)

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bɑːd]	[ˈbɑːdat]	[ˈbɑːdad]	[ˈbɑːdadə]	‘bathe’
	*[batː]	*[badː]	*[ˈbadːə]	

Since the suffix’s consonant is now in a stressless syllable, it surfaces as short, and there is no long consonant which forces the laxing of the vowel: it remains long and tense throughout the paradigm.

Stems of the form C_0ʉd are easily found, but these tend to be part of the fourth conjugation, which forms the supine and participle with exceptional suffixation, and the preterite by means of ablaut.

(249)

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bjʉːd]	[ˈbjʉːdit]	[ˈbjʉːden]	[ˈbjøːd]	‘invite’
	*[bjətː]	*[bjətː]	*[ˈbjədːə]	

In paradigms like this, tense [ʉ] never alternates with its lax counterpart [ɵ].

Just as the vowels [$ɑ_T$, a_L] and [$ʉ_T$, $ɵ_L$] are underrepresented in tenseness-shifting paradigms with stems of the form C_0Vd (‘second conjugation’), they are also not represented in tenseness-shifting paradigms with stems of the form C_0Vt (‘second conjugation’):[54]

(250)

CORRESP.	#ATTESTED	STEM	SUPINE	GLOSS
$ɑ_T \rightarrow a_L$	0 (PREDICTED)	--	--	--
$ʉ_T \rightarrow ɵ_L$	0 (PREDICTED)	--	--	--
$ɛ_T \rightarrow ɛ̝_L$	1	ˈm[ɛː]t	ˈm[ɛ̝]tː	‘measure’
$y_T \rightarrow ʏ_L$	1	ˈb[yː]ta	ˈb[ʏ]tː	‘exchange’
$e_T \rightarrow ɛ̝_L$	0	--	--	--
$o_T \rightarrow ɔ_L$	0	--	--	--

[54] For a complete list, see appendix 4.

$u_T \rightarrow ʊ_L$	0	--	--	--
$i_T \rightarrow ɪ_L$	0	--	--	--
$ø_T \rightarrow ø̞_L$	3	ˈɧ[øː]ta	ˈɧ[ø̞]tː	‘look after’

This is not due to a lack of stems of the form C_0ɑt and C_0ʉt. There are many stems of this form; but again, they tend to be part of the first conjugation, with a thematic vowel which splits the two dental consonants.

(251)

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[hɑːt]	[ˈhɑːtat]	[ˈhɑːtad]	[ˈhɑːtadə]	‘hate’
	*[hatː]	*[hatː]	*[ˈhatːə]	
[kʉːt]	[ˈkʉːtat]	[ˈkʉːtad]	[ˈkʉːtadə]	‘run’
	*[kətː]	*[kətː]	*[ˈkətːə]	

Note how, once again, the vowel remains long and tense throughout the paradigm. It never alternates with the lax vowel.

Stems of the form C_0ʉt are also attested in the fourth conjugation, featuring ablaut:

(252)

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[ˈjʉːta]	[ˈjʉːtit]	[ˈjʉːten]	[jøːt]	‘cast metal’
	*[jətː]	*[jətː]	*[ˈjətːə]	

As expected, tense [ʉ] never alternates with its lax counterpart [ə].

4.7 Blocked laxing before geminate suffixes: adjectives

4.7.1 C_0V stems

Some Swedish adjectives of the form C_0V feature tense/lax alternation when a geminate neuter suffix is affixed.

(253)

STEM	NEUTER	GLOSS
n[yː$_T$]	n[ʏ$_L$]tː	'new'

The vowel pairs [ɑ$_T$, a$_L$] and [ʉ$_T$, ɵ$_L$] are underrepresented in these paradigms.[55]

(254)

CORRESP.	# ATTESTED	STEM	NEUTER	GLOSS
ɑ$_T$ → a$_L$	0 (PREDICTED)	--	--	--
ʉ$_T$ → ɵ$_L$	0 (PREDICTED)	--	--	--
ɛ$_T$ → ɛ̝$_L$	0	--	--	--
y$_T$ → ʏ$_L$	1	n[yː]	n[ʏ]tː	'new'
e$_T$ → ɛ	0	--	--	--
o$_T$ → ɔ$_L$	3	bl[oː]	bl[ɔ]tː	'blue'
u$_T$ → ʊ$_L$	0	--	--	--
i$_T$ → ɪ$_L$	1	fr[iː]	fr[ɪ]tː	'free'
ø$_T$ → ø̞$_L$	1	sl[øː]	sl[ø̞]tː	'lazy'

Note that this is not due to a lack of stems of the form C_0ɑ. the word [brɑː] 'good' is a familiar word in the Swedish lexicon. Strikingly, the neuter of the word features an exceptional null suffix:

(255)

*CORRESP.	STEM	*	SR	GLOSS
*ɑ$_T$ → a$_L$	br[ɑ$_T$ː]	*br[a$_L$]tː	br[ɑ$_T$ː]	'good'

4.7.2 C_0Vd and C_0Vt stems

Stems of the form C_0Vd and C_0Vt feature alternations in vowel length and tenseness in the neuter form, just like stems of the form C_0V.

[55] For a complete list, see Appendix 5. Lists are obtained from Holmes & Hinchliffe 2003.

(256)

STEM	NEUTER	GLOSS
br[eː$_T$]d	br[ɛ̝$_L$]tː	'broad'
h[eː$_T$]t	h[ɛ̝$_L$]tː	'hot'

The vowels [ɑ$_T$, a$_L$] and [ʉ$_T$, ɵ$_L$] are underrepresented in these paradigms. There is only one[56] adjective with the alternation [ɑ$_T$, a$_L$] among adjectives with the form C_0Vd, and there is no adjective with the alternation [ʉ$_T$, ɵ$_L$] among these adjectives. The complete distribution is as follows:[57]

(257)

CORRESP.	# ATTESTED	STEM	NEUTER	GLOSS
ɑ$_T$ → a$_L$	1	gl[ɑː]d	gl[a]tː	'happy'
ʉ$_T$ → ɵ$_L$	0 (PREDICTED)	--	--	--
ɛ$_T$ → ɛ̝$_L$	1	sp[ɛː]d	sp[ɛ̝]tː	'tender'
y$_T$ → ʏ$_L$	0	--	--	--
e$_T$ → ɛ	2	br[eː]d	br[ɛ̝]tː	'broad'
ˈo$_T$ → ɔ$_L$	0	--	--	--
u$_T$ → ʊ$_L$	0	--	--	--
i$_T$ → ɪ$_L$	4	soˈl[iː]d	soˈl[ɪ]tː	'solid'
ø$_T$ → ø$_L$	3	r[øː]d	r[ø]tː	'red'

Likewise, there is no regular adjective of the form C_0Vt with the alternation [ɑ$_T$, a$_L$] or [ʉ$_T$, ɵ$_L$]. The complete distribution of these adjectives, grouped by stressed vowel, is as follows:[58]

[56] The word 'happy' has an overt form instead of a paradigm gap, due to its exceedingly high frequency. See chapter 5 for discussion and formalism.
[57] For a complete list, see appendix 6.
[58] For a complete list, see appendix 7.

(258)

CORRESP.	# ATTESTED	STEM	NEUTER	GLOSS
$ɑ_T \rightarrow a_L$	0 (PREDICTED)	--	--	--
$ʉ_T \rightarrow ɵ_L$	0 (PREDICTED)	--	--	--
$ɛ_T \rightarrow ɛ̝_L$	2	t[ɛː]t	t[ɛ̝]tː	'tight'
$y_T \rightarrow ʏ_L$	0	--	--	--
$e_T \rightarrow ɛ$	2	h[eː]t	h[ɛ̝]tː	'hot'
$o_T \rightarrow ɔ_L$	1	v[oː]t	v[ɔ]tː	'wet'
$u_T \rightarrow ʊ_L$	0	--	--	--
$i_T \rightarrow ɪ_L$	1	v[iː]t	v[ɪ]tː	'white'
$ø_T \rightarrow ø_L$	2	s[øː]t	s[ø̞]tː	'sweet'

Note that this is not due to a lack of lexical items of the form $C_0ɑt$. The word for 'lazy' is [$lɑ_T$ːt], and this is famously ineffable in the neuter (Cederschiöld 1912; cited and discussed in Raffelsiefen 2002). The same is true for the word [$flɑ_T$ːt] 'flat'. Where we would expect outputs of the form [latː] and [flatː], there are instead gaps in the paradigms:

(259)

*CORRESP.	STEM	*	NEUTER	GLOSS
$*ɑ_T \rightarrow a_L$	[$lɑ_T$ːt]	*[la_Ltː]	NULL PARSE	'lazy'
$*ɑ_T \rightarrow a_L$	[$flɑ_T$ːt]	*[fla_Ltː]	NULL PARSE	'flat'

Since the tense-to-lax mapping in the pair [$ɑ_T$, a_L] involves the greatest perceptual distance, the relevant *MAP constraint is ranked high[59]; in particular, it is ranked higher than M-PARSE, the constraint that penalizes the NULL PARSE candidate

[59] This is a simplification. Morpheme frequency is also relevant, as discussed in chapter 5.

‘⊙’(Prince & Smolensky 1993/2004). So, for the word ‘lazy, n.’, the NULL PARSE candidate is the optimal candidate.

(260)

/lɑ$_T$t + tː/ ‘lazy, n.’ cf. SR [lɑ$_T$ːt]	$\sigma_{\mu\mu}$ ↔ [+ stress]	I-O IDENT (Long C)	[+ LONG] ↔ [+ TENSE]	*MAP (α_T, a_L)	M-PARSE	*MAP ($\emptyset_T$, $\emptyset_L$)
a. lɑ$_T$ːtː	*!					
b. lɑ$_T$ːt		*!				
c. la$_T$tː			*!			
d. lɑ$_L$tː				*!		
e. > ⊙					*	

The tense-to-lax mapping in other vowel pairs involves a smaller perceptual distance, so the respective *MAP constraints are ranked lower; in particular, they are ranked lower than M-PARSE. So, for ‘sweet’, the candidate violating *MAP is optimal, and the NULL PARSE candidate is non-optimal.[60]

[60] However, other tense-lax mappings can be problematic, given sufficiently low morpheme frequency. Prosodic factors also influence tense-lax mapping. This is discussed in chapter 5.

(261)

	/søt + tː/ ‘sweet, n.’ cf. SR [he$_T$ːt]	$\sigma_{\mu\mu}$ ↔ [+ stress]	I-O IDENT (Long C)	[+ LONG] ↔ [+ TENSE]	*MAP ($ɑ_T$, a_L)	M-PARSE	*MAP ($ø_T$, $ø̞_L$)
a.	sø$_T$ːtː	*!					
b.	sø$_T$ːt		*!				
c.	sø$_T$tː			*!			
d. >	sø̞$_L$tː						*
e.	⊙					*!	

4.8 Statistical analysis of paradigm structure

4.8.1 Introduction

Fisher’s Exact Test (Fisher 1922) assesses the significance of contingency between two classifications. In the present study, it establishes whether vowel type and representation (or under-representation) in tenseness-changing paradigms is correlated. In particular, are the vowel pairs [ɑ, a] and [ʉ, ɵ] underrepresented in those verbal and adjectival paradigms which feature ‘dental gemination’?

Up to now, individual adjective paradigms and verbal conjugations have been considered in isolation, for expositional clarity. An artifact of this approach is that there was no way to statistically establish the underrepresentation of the vowel pairs [ɑ, a] and [ʉ, ɵ] in the paradigms: the numbers were simply too small.

To establish that that the vowels [ɑ, a] and [ʉ, ɵ] are in fact underrepresented in the vowel-changing verbal conjugations and the adjectival paradigms, I performed

Fisher's Exact Test comparing the distribution of the vowels [ɑ, a] and [ʉ, ɵ] with the other vowels. A 2x2 matrix was constructed, where the vowel type was identified in one axis and presence/lack of tenseness alternation was identified in the other axis.

(262)

	Dental gemination (tenseness-shifting)	Other verbal and adjectival paradigms (not tenseness-shifting)
[ɑ, a] and [ʉ, ɵ]		
other vowels		

I focused on words of the structure C_0V:, C_0V:d, and C_0V:t. Other word types are irrelevant, since only these regularly trigger vowel shortening when affixed to a geminate consonant. The presence of tenseness alternation was identified in the regular 'dental gemination' paradigms. The absence of tenseness alternation was identified in the following contexts:

- exceptional paradigm structure (unaffixed or ineffable forms)
- first conjugation verbal forms (with a thematic [a] inserted before an unstressed suffix, such that the stem is identical in all forms of the suffix)
- fourth conjugation verbal forms (with ablaut)

4.8.2 Shifts in tenseness: the 'dental gemination' pattern

The patterning of vowels in the 'dental gemination' paradigms has been discussed in the preceding sections. The following chart summarizes the 'dental gemination' patterns for the vowels [ɑ, a] and [ʉ, ɵ]. The first column identifies the

correspondence pair. Columns 2 through 8 are paradigm types discussed above. The number in the chart identifies the number of words of the relevant type which features the correspondence. The 9th column is the sum of the numbers in columns 2 through 8. The number listed under 'total' is the sum of numbers in column 9.

(263)

CORRESP.	verb 3 conj. CVː	verb ex3conj. CVː	verb 2conj CVːd	verb 2conj CVːt	adj CVː	adj CVːd	adj CVːt	sum
$ɑ_T \rightarrow a_L$	0	3	0	0	0	1	0	4
$ʉ_T \rightarrow ɵ_L$	0	0	0	0	0	0	0	0
							total:	4

Three exceptional verbs of the form C_0Vː featured the [ɑ, a] correspondence: the high-frequency word [hɑː] 'have' with the preterite [hadːə]; and the non-standard colloquial supines of [tɑː] 'take' and [drɑː] 'pull', which are [tatː] and [dratː]. One regular adjective of the form C_0Vːd was found: the high-frequency adjective [glɑːd] with the neuter [glatː].

The following chart summarizes the 'dental gemination' patterns for the other vowels.

(264)

CORRESP.	verb 3 conj. CVː	verb ex3conj. CVː	verb 2conj CVːd	verb 2conj. CVːt	adj CVː	adj CVːd	adj CVːt	sum
$ɛ_T \rightarrow ɛ̝_L$	3	0	0	2	0	1	1	7
$y_T \rightarrow ʏ_L$	8	0	4	1	1	0	0	14
$e_T \rightarrow ɛ$	4	4	1	0	0	2	2	13
$o_T \rightarrow ɔ_L$	11	4	0	0	3	0	1	19
$u_T \rightarrow ʊ_L$	9	0	0	0	0	0	0	9

$i_T \rightarrow ɪ_L$	0	1	0	0	1	4	1	7
$ø_T \rightarrow ø_L$	2	1	2	3	1	3	2	14
							total:	83

A total of 83 such adjectives and verbs were found.

This lets us begin to fill out the matrix, to apply Fisher's Exact Test:

(265)

	Dental gemination (tenseness-shifting)	Other verbal and adjectival paradigms (not tenseness-shifting)
[ɑ, a] and [ʉ, ɵ]	4	
other vowels	83	

4.8.3 Non-shifting verbal forms

As noted, three sources for non-shifting tenseness in adjectival and verbal paradigms are exceptional paradigm structure, paradigms with thematic unstressed vowels, and ablaut paradigms.

Regarding exceptional paradigm structure, the following chart lists adjectives of the form C_0V:, C_0V:d, or C_0V:t featuring [ɑ] or [ʉ] which are either unaffixed or ineffable in the neuter form.[61] The neuter form would in the regular case feature an affixed [tː] and a short lax vowel.

[61] In this and subsequent charts, I abstract away from iambic roots that resist vowel shortening: for example, the word [prɪvɑːt] has a haplological neuter (*[prɪvatː]) , but it is unclear whether this reveals much of interest regarding the vowel alternation. Iambs appear to resist alternation to a greater extent than monosyllabic stems; thereby introducing a confound in the discussion. This is discussed in Chapter 5.

(266) C_0Vː [brɑː] ‘good’ (haplological neuter)

C_0Vːd [grɑːd] ‘straight’ (ineffable neuter)

C_0Vːt [lɑːt] ‘lazy’ (ineffable neuter)

[flɑːt] ‘flat’ (ineffable neuter)

In total, there are 4 such adjectives.

The following chart lists adjectives of the form C_0Vː, C_0Vːd, or C_0Vːt featuring other vowels which are ineffable in the neuter form (Sigurd (1965:103); *SAG* (1999: 210-214)).

(267) C_0Vː [kryː] ‘healthy’

C_0Vːd [vreːd] ‘straight’

[çeːd] ‘fed up’

[pryːd] ‘prudish’

[snøːd] ‘sordid’

C_0Vːt [soːt] ‘intimate’

[koːt] ‘horny’

In total, there are 7 such adjectives.

These values can be added to the matrix for Fisher’s Exact Test:

(268)

	Dental gemination (tenseness-shifting)	Other verbal and adjectival paradigms (not tenseness-shifting)
[ɑ, a] and [ʉ, ɵ]	4	4 +
other vowels	83	7 +

The second case where verbal stems remain unchanged in paradigms are verbs of the first conjugation. These feature a thematic unstressed vowel [a] between the stem

and the suffix. Since this thematic vowel is unstressed, the underlyingly geminate suffix surfaces as short, since all segments in unstressed syllables are short in Swedish. The stressed vowel surfaces as long in all parts of the paradigm, since its syllable remains open throughout the paradigm. Compare the 'dental gemination' verb [ruː] 'row' with the first conjugation [ruː-a] 'amuse':

(269)

STEM	PARTICIPLE	SUPINE	PRETERITE	GLOSS
r[uː]	ˈr[ʊ] + dː	ˈr[ʊ] + tː	ˈr[ʊ] + dːə	'row'
r[uː]-a	ˈr[uː]-a + d	ˈr[uː]-a + t	ˈr[uː]-a + də	'amuse'

The 'dental gemination' verb features a tense/lax correspondence, but the first conjugation verb only features the tense vowel.

First conjugation verbs of the form C_0Vːd and C_0Vːt similarly maintain their vowel length throughout the paradigms, since the stressed syllable is always open, and the vowel is always long. Consider the verbs [bluːd-a] 'put blood on' and [ruːt-a] 'dig':

(270)

STEM	PARTICIPLE	SUPINE	PRETERITE	GLOSS
ˈbl[uː]d-a	ˈbl[uː]d-a + d	ˈbl[uː]d-a + t	ˈbl[uː]d-a + də	'put blood on'
ˈr[uː]t-a	ˈr[uː]t-a + d	ˈr[uː]t-a + t	ˈr[uː]t-a + də	'dig'

Again, these verbs of the first conjugation maintain vowel tenseness under suffixation. The following chart lists the number of first conjugation verbs of the form C_0Vː, C_0Vːd and C_0Vːt, where the vowel is [ɑ] or [ʉ].[62] The examples are organized by stem type, and the number next to the stem type identifies the total number of examples for that type.

[62] For specific examples, see appendix 8.

(271)

VOWEL	CVː	CVːd	CVːt	sum
ɑː	0	6	8	14
ʉː	4	3	13	20
			total	34

The total number of first conjugation verbs of the the form C_0Vː, C_0Vːd and C_0Vːt featuring the vowels [ɑ, ʉ] is 34.

The following chart lists the number of first conjugation verbs of the form C_0Vː, C_0Vːd, and C_0Vːt; where the vowel is something other than [ɑ] or [ʉ].[63]

(272)

VOWEL	C_0Vː	C_0Vːd	C_0Vːt	sum
ɛː	5	2	6	13
yː	6	0	0	6
eː	2	2	13	17
oː	5	3	5	13
uː	4	4	9	17
iː	5	1	6	12
øː	6	4	5	15
			total	93

The total number of first conjugation verbs of the form C_0Vː, C_0Vːd and C_0Vːt featuring vowels other than [ɑ, ʉ] is 93. With the earlier observation, that the total number of first conjugation verbs of the form C_0Vː, C_0Vːd and C_0Vːt featuring the vowels [ɑ, ʉ] is 34, we can continue to fill out the matrix:

[63] For specific examples, see appendix 9.

(273)

	Dental gemination (tenseness-shifting)	Other verbal and adjectival paradigms (not tenseness-shifting)
[ɑ, a] and [ʉ, ɵ]	4	4 + 34 +
other vowels	83	7 + 93 +

The third case where shifts in tenseness are avoided are the 'fourth conjugation' pattern, where the stem is manipulated by ablaut. For example, in standard Swedish, the word 'pull' surfaces with tense [ɑː] and tense [uː] in its paradigm; there is no [ɑː]~[a] correspondence.

(274)

STEM	PARTICIPLE	SUPINE	PRETERITE	GLOSS
ˈdr[ɑː]	ˈdr[ɑː]gən	ˈdr[ɑː]gɪt	ˈdr[uː]g	'pull'

The following chart lists the number of fourth conjugation verbs of the form C_0Vː, C_0Vːd and C_0Vːt, where the vowel is [ɑ] or [ʉ].[64]

(275)

VOWEL	CVː	CVːd	CVːt	sum
ɑː	2	0	0	2
ʉː	0	3	6	9
			total	11

The total number of words of this type is 11.

The following chart lists the number of fourth conjugation verbs of the form C_0Vː, C_0Vːd and C_0Vːt, where the vowel is something other than [ɑ] or [ʉ].[65]

[64] For specific examples, see appendix 10.
[65] For specific examples, see appendix 11.

(276)

VOWEL	CVː	CVːd	CVːt	sum
ɛː	0	0	1	1
yː	0	0	7	7
eː	0	0	0	0
oː	1	0	2	3
uː	0	0	0	0
iː	0	8	4	12
øː	0	0	0	0
			total	23

The total number of words of this type is 23. Noting that the corresponding number for the stems featuring the vowels [ɑ] and [ʉ] was 11, we can complete the matrix started above.

(277)

	Dental gemination (tenseness-shifting)	Other verbal and adjectival paradigms (not tenseness-shifting)
[ɑ, a] and [ʉ, ɵ]	4	$4+34+11=49$
other vowels	83	$7+93+23=123$

Applying Fisher's Exact Test to this matrix, we establish that the vowel pairs [ɑ, a] and [ʉ, ɵ] are significantly underrepresented in the 'dental gemination' paradigms, which feature a change in tenseness. The effect is highly significant: $p < .0001$.

4.9 Distinctions between derivation and inflection

4.9.1 The puzzle

The data we have considered up to now present a ranking paradox. The ineffable neuter of 'lazy' suggests *MAP (a_T , a_L) ≫ M-PARSE, as the following tableau shows:

(278)

/la$_T$t + t:/ 'lazy, n.' cf. SR [la$_T$:t]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔[+TENSE]	*MAP (a_T, a_L)	M-PARSE
a. la$_T$:t:	*!			
b. la$_T$t:		*!		
c. la$_L$t:			*!	
d. > ⊙				*

The low ranking of M-PARSE makes the NULL PARSE candidate '⊙' optimal. However, this yields wrong output for 'nickname for Jan'. Recall from section 4.3.1 that this is not ineffable, but has an overt form with a short lax vowel—this is candidate (c) below.

(279)

CVC:ə 'nickname for Jan' cf. SR [jɑ$_T$:n]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔[+TENSE]	*MAP (α_T, a_L)	M-PARSE
a. jɑ$_T$:n:ə	*!			
b. jɑ$_T$n:ə		*!		
c. > ja$_L$n:ə			*!	
d. 💣 NULL PARSE				*

By the same token, the low ranking of M-PARSE predicts an ineffable output for 'algebraic'. In fact, an explicit output with a long tense vowel—candidate (c) below—is the attested form, as discussed in section 4.3.2.

(280)

/algebra +isk/ 'algebraic' cf. SR [ˈalgebra]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔[+TENSE]	*MAP (α_T, a_L)	M-PARSE
a. algeˈbra$_L$isk	*!			
b. algeˈbra:$_L$isk		*!		
c. > algeˈbrɑ$_T$:isk			*!	
d. 💣 ⊙				*

In both of the two preceding tableaux, candidate (c) is the attested form, but it is incorrectly ruled out by the low ranking of M-PARSE.

The attested forms of the nickname of [jɑːn] and the *isk*-form of [algebra] suggest the inverted ranking, M-PARSE ≫ *MAP ($ɑ_T$, a_L). Such a ranking would result in candidate (c) being the winner in the last two tableaux:

(281)

	CVCːə 'nickname for Jan' cf SR [jɑː$_T$n]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔[+TENSE]	M-PARSE	*MAP ($ɑ_T$, a_L)
a.	jɑ$_T$ːnːə	*!			
b.	jɑ$_T$nːə		*!		
c. >	ja$_L$nːə				*
d.	⊙			*!	

(282)

	/algebra + isk/ ‘algebraic’ cf. SR [algebra]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔[+TENSE]	M-PARSE	*MAP (a_T, a_L)
a.	alge^{l}bra$_L$isk	*!			
b.	alge^{l}bra$_L$ːisk		*!		
c. >	alge^{l}brɑ$_T$ːisk				*
d.	⊙			*!	

However, this of course generates the wrong output for neuter of ‘lazy’:

(283)

	/lɑ$_T$t + tː/ ‘lazy, n.’ cf. SR [lɑ$_T$ːt]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔[+TENSE]	M-PARSE	*MAP (a_T, a_L)
a.	lɑ$_T$ːtː	*!			
b.	lɑ$_T$tː		*!		
c. 💣	la$_L$tː				*
d. >	⊙			*!	

4.9.2 Towards a solution

It appears that the *MAP ($ɑ_T$, a_L) for 'lazy, n.' is ranked differently from the *MAP ($ɑ_T$, a_L) for 'algebraic' and 'nickname for Jan'. If we could separate the *MAP ($ɑ_T$,a_L) constraints, and rank them differently with respect to M-PARSE, we could generate the correct outputs in the three distinct cases:

(284)

/l$ɑ_T$t + tː/ 'lazy, n.' cf. SR [l$ɑ_T$ːt]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔ [+TENSE]	*MAP ($ɑ_T$,a_L) /lat + tː/	M-PARSE	*MAP ($ɑ_T$,a_L) /janːe/, /algebraisk/
a. lɑ$_T$ːtː	*!				
b. lɑ$_T$tː		*!			
c. la$_L$tː			*!		
d. > ⊙				*	

(285)

	CVC:ə 'nickname for Jan' cf SR [jɑ:$_T$n]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔ [+TENSE]	*MAP (a_T,a_L) /lat +t:/	M-PARSE	*MAP (a_T,a_L) /jan:e/; /algebraisk/
a.	jɑ$_T$:n:ə	*!				
b.	jɑ$_T$n:ə		*!			
c. >	ja$_L$n:ə					*
d.	⊙				*!	

(286)

	/algebra + isk/ 'algebraic' cf. SR [ˈalgebra]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔ [+TENSE]	*MAP (a_T,a_L) /lat +t:/	M-PARSE	*MAP (a_T,a_L) /jan:e/; /algebraisk/
a.	algeˈbra$_L$isk	*!				
b.	algeˈbra$_L$:isk		*!			
c. >	algebrɑ$_T$:isk					*
d.	⊙				*!	

The crucial difference between neuter affixation, on the one hand, and nickname formation and *–isk* affixation, on the other hand, has to do with the type of morphological process involved. The neuter affix involves inflection; while nickname-

formation and *–isk* affixation involve derivation. Inflectional forms require tighter O-O correspondence than derivational forms.

Assume that the difference between inflectional and derivational affixes involves constraint type. In particular, a given *MAP (X,Y) comes in two forms, namely *MAP (X,Y)/+INFL and *MAP (X,Y)/-INFL, where the former is violated when a mapping from X to Y occurs in an inflectional form, and the latter is violated when a mapping from X to Y occurs in a derivational form. Furthermore, assume the universal ranking *MAP (X,Y)/+INFL ≫*MAP (X,Y)/-INFL. That is, unfaithful mappings in inflected forms are penalized more severely than the same unfaithful mapping in a derivational form.

Take one instantiation of this generalization: *MAP (α_T , a_L)/+INFL ≫ *MAP (α_T , a_L)/-INFL. The unfaithful mapping from [α_T] to [a_L] in an inflected form is more severely penalized than the same mapping in a derivational form. This generates the ineffability of the neuter form of 'lazy', since the neuter suffix counts as an inflectional suffix:

(287)

/lɑ$_T$t + tː/ ‘lazy, n.’ cf. SR [lɑ$_T$ːt]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	*MAP (ɑ$_T$, a$_L$)/ +INFL	M-PARSE	*MAP (ɑ$_T$, a$_L$)/ -INFL
a. lɑ$_T$ːtː	*!				
b. lɑ$_T$tː		*!			
c. la$_L$tː			*!		
d. > ⊙				*	

This also generates the explicit output for the nickname for [jɑːn], which is [janːə]. Crucially, this is a derivational form, so the relevant *MAP constraint is ranked low; it is ranked lower than M-PARSE, which penalizes the NULL PARSE candidate ‘Θ’.

CVCːə ‘nickname for Jan’ cf SR [jɑː$_T$n]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	*MAP (ɑ$_T$, a$_L$)/ +INFL	M-PARSE	*MAP (ɑ$_T$, a$_L$)/ -INFL
a. ˈjɑ$_T$ːnːə	*!				
b. ˈjɑ$_T$nːə		*!			
c. > ˈja$_L$nːə					*
d. ⊙				*!	

The same constraint generates the explicit output for *–isk* form generated with the stem [ˈalgebra], which is [algeˈbrɑːisk]. Again, this is a derivational form, and the relevant *MAP constraint is ranked lower than M-PARSE.

(288)

	/algebra + isk/ 'algebraic' cf. SR [ˈalgebra]	$\sigma_{\mu\mu} \leftrightarrow$ [+stress]	[+LONG] $\leftrightarrow$ [+TENSE]	*MAP (α_T, a_L)/ +INFL	M-PARSE	*MAP (α_T, a_L)/ -INFL
a.	algeˈbra$_L$isk	*!				
b.	algeˈbra$_L$ːisk		*!			
c. >	algeˈbrɑ$_T$ːisk					*
d.	⊙				*!	

The ordering paradox presented at the beginning of the section is resolved by splitting the *MAP constraints into two types, *MAP (X,Y)/+INFL , which applies to inflectional forms; and *MAP (X,Y)/-INFL, which applies to derivational forms.

4.10 An argument against Evolutionary Phonology

The present account assumes that the phonological system makes direct reference to perceptual distances in the ranking of the *MAP constraints. We noted above the relative ranking *MAP (α_T , a_L)/+INFL ≫ *MAP (α_T , a_L)/-INFL. Notice that the feature ±INFL is a marker of grammatical category. Recall also that the ranking mechanism for the *MAP constraints makes direct reference to primary content; i.e., perceptual distance:

(289) =(223) If $\Delta({}^{A}X^{B}, {}^{C}Y^{D})$ > $\Delta({}^{A'}X'^{B'}, {}^{C'}Y'^{D'})$

then $*\text{MAP } S_1S_2\ ({}^{A}X^{B}, {}^{C}Y^{D}) \gg *\text{MAP } S_1S_2\ ({}^{A'}X'^{B'}, {}^{C'}Y'^{D'})$

We have, then, a constraint family that makes reference to both grammatical class and to primary phonetic content. If this is correct, it constitutes a counterexample to a central tenet of Evolutionary Phonology, where grammar does not encode primary content (Blevins 2004:27).[66]

The challenge that Evolutionists must face is to come up with a mechanism that blocks correspondence in the inflectional system without blocking correspondence in the derivational system, without letting the grammar refer to perceptual distance.

4.11 Raffelsiefen's approach to ineffable neuter of [lɑːt] 'lazy'

The present account is not the first attempt at accounting for the ineffability of words like 'lazy, n.' in Swedish.[67] Raffelsiefen 2002 provides an account, where the gemination of the neuter suffix /t/ is driven by minimality, as discussed in Chapter 3.

In contrast to the present proposal, Raffelsiefen 2002 assumes that the neuter suffix is singleton /t/, not geminate /tː/. Recall from Chapter 3 that she assumes that singleton word-final consonants are non-moraic. Geminate wordfinal consonants are moraic; also, they are ambisyllabic, due to 'virtual' syllables. Recall, furthermore, that alternations in segment duration are regarded as a phonetic effect, called stretching. The lengthening of the neuter suffix is the result of the constraints MIN and AMBI [S-site]:

---

[66] See section 1.8.

[67] As mentioned, Kiefer 1970 and Linell 1972 provide an abstract morphological account for the ineffability of the word; these are not directly relevant to the present phonological discussion.

(290) MIN Morphologically marked words must be minimally bimoraic.

AMBI [S-site] Ambisyllabic consonants are stretching sites.

There is also a constraint on paradigmatic uniformity of stretching, such that the same sound is long in all members of a given paradigm:

(291) O-O IDENT [S-site] The stretching site must be identical for all members of a paradigm

This is ranked lower than the constraints MIN and AMBI [S-site].

Following Elert (1979), Raffelsiefen assumes that Swedish [ɑ] is [+back], whereas [a] is [-back]. Given that these sounds have different values for [back], the mapping [ɑ] → [a] results in a violation of O-O IDENT [back]. This constraint is crucially ranked higher than M-PARSE, such that the NULL PARSE candidate is more optimal than the competing candidate [latː].

(292)

/lɑt +t/ ‘lazy, n.’ cf SR [lɑːt]	MIN	O-O IDENT [BACK]	M-PARSE
a. $lɑ_{\mu}ː[_{\sigma}t$	*!		
b. $la_{\mu}t_{\mu}ː$		*!	
c. > ⊙			*

Raffelsiefen does not relativize the O-O IDENT to paradigm type. This constraint with its ranking predicts that the vowels [ɑ] and [a] should never alternate in the Swedish language. This is so, because the NULL PARSE candidate will always be more optimal than the candidate featuring altered vowel quality. Since O-O IDENT [back] lacks an index to distinguish inflectional from derivational processes, the ranking also generates ineffability in nicknames:

(293)

	CVCːə ‘nickname for Jan’ cf. SR [jɑːn]	O-O IDENT [BACK]	M-PARSE
a. >	$ja_{\mu}n_{\mu}$ːə	*	
b.	⊙		*

This is problematic: we saw above that they the vowels [ɑ] and [a] do alternate in nicknames. By the same token, that constraint ranking predicts that the vowels [ɑ] and [a] should not alternate in *–isk* formations:

(294)

	/algebra + isk/ ‘algebraic’ cf. SR [ˈalgebra]	O-O IDENT [BACK]	M-PARSE
a. >	algeˈbrɑːisk	*	
b.	⊙		*

We know, however, that these vowels do in fact alternate.

The present proposal provides a principled reason for blocked correspondence between vowels: perceptual distance and paradigm type both play a role in the grammar.[68]

[68] The proposal will be further refined in the next chapter, where correspondence is sensitive to morpheme frequency.

4.12 Local Summary

I have argued for the existence of the constraint family *MAP S_1S_2 ($^{A}X^{B}$,$^{C}Y^{D}$)/ ± INFL. The constraint rules out the mapping from X in context A_B, to Y in context C_D. Greater perceptual distance in the mapping results in a higher ranked constraint. Given two identical mappings, one inflectional, and one derivational, the inflectional mapping is penalized more severely; the constraint marked +INFL is ranked higher than the constraint marked –INFL. A given constraint in this constraint-family makes reference to both perceptual distance and paradigm type, implying that primary content in the form of perceptual distance is part of the grammar.

5 Morpheme frequency and an extension of *MAP

5.1 Introduction

In the previous chapter, we attributed the ineffability of the neuter form of [lɑːt] 'lazy' to the great perceptual distance between the tense/lax vowel pair [ɑ, a]. This vowel pair and the pair [ʉ, ɵ] were shown to be underrepresented in tenseness-changing verbal and adjectival paradigms. However, perceptual distance cannot be the whole story behind the ineffability: the account both overgenerates ineffability and undergenerates ineffability in Swedish. It overgenerates ineffability, since there are cases where the vowel pairs [ɑ, a] do in fact alternate: the adjective [glɑːd] has the neuter form [glatː]. It undergenerates ineffability, since there are tense/lax vowel pairs other than [ɑ, a] and [ʉ, ɵ] that generate ineffability: the adjective [vreːd] 'angry' is ineffable in the neuter (*[vrɛ̝tː]). Clearly, there is some additional factor influencing correspondence and ineffability, other than mere perceptual distance.

The crucial additional factor is morpheme frequency (Bybee 2001, Coetzee 2009). Two forms that are phonotactically isomorphic can differ as to whether they feature overt forms in their paradigm, or whether they instead feature paradigm gaps. Morphemes with higher frequency tend to have overt forms; morphemes with lower frequency tend to feature paradigm gaps. We speculate that lexical representations feature frequency indices. These frequency indices have implications for the morpheme's interactions with Faithfulness constraints. In the account presented, Faithfulness constraints are relativized to frequency, and the frequency index influences the constraint's ranking. Faithfulness constraints relativized to lower frequency indices are ranked higher. Lower morpheme frequency results in more severe constraints on faithfulness. Faithfulness constraints relativized to higher frequency indices are ranked lower. Higher morpheme frequency results in less severe constraints on faithfulness.

We review Hammond 1999, which argues that the Rhythm Rule in English is sensitive to frequency. We then provide a formalism for Hammond's facts, and apply it to the Swedish facts. The same formalism can be used to analyze Spanish cases of ineffability, which, like Swedish, are sensitive to frequency. We argue that ineffability in Russian end-stressed nouns resists a purely frequency driven analysis. We also provide some psycholinguistic background, showing that the relation between frequency and unfaithfulness is independently noted in perceptual biases, such as the Broadbent effect and the Ganong effect. Finally we extend the proposal to apply to blocking of flapping in low frequency words in English.

5.2 Paradigm gaps and morpheme frequency in Swedish: the data

5.2.1 Background

Swedish is known for paradigm gaps, and considerable work has been devoted to their analysis (Eliasson 1975, Iverson 1981, Raffelsiefen 2002, McCarthy & Wolf 2005, Buchanan 2007). The present study focuses on ineffability in the neuter paradigm. As shown in Chapter 3, the UR of the neuter suffix is /t:/ (Teleman 1969). The affixation of this geminate suffix results in changes in stem, such that it is unfaithful to the unaffixed form. The unfaithfulness involves interactions between the suffix, on the one hand; and the immediately preceding stem-final sound, on the other hand.

5.2.2 Unfaithful mappings in the neuter

Recall some phonological and phonotactic generalizations from Chapter 3 and Chapter 4. Geminate suffixes trigger shortening and laxing in stems of the form C_0V, C_0Vd, and C_0Vt.

(295)

STEM	NEUTER	GLOSS
bl[oː$_T$]	bl[ɔ$_L$] + tː	'blue'
v[iː$_T$]t	v[ɪ$_L$] + tː	'white'
v[iː$_T$]d	v[ɪ$_L$] + tː	'wide'

The neuter suffix also triggers devoicing in stem-final obstruents (Linell et al. 1971:105, Hellberg 1974:144, *SAG* 1999:211).

(296)

STEM	NEUTER	GLOSS
loː[g]	loː[g̊] + t	'low'

In these ways, the suffixation of the neuter results in unfaithful mappings in the vowel and coda consonant of the stem.

5.2.3 Unfaithful mapping and ineffability

In the examples above, the alternations resulted in changes in the stem, but ineffability did not result. If the alternations are sufficiently radical, or if the word is of sufficiently low frequency, ineffability arises. The following chart shows the relevance of frequency in ineffability. The frequency indices are obtained from the search engine Google on April 20, 2010. The morpheme in question may be either a stem or a suffix.

(297)

stem type	# with gaps	Frequency range	# without gaps	Frequency range
C_0ɑːD (D = {t,d})	3	6,980-827,000	1	2,270,000
C_0yː(d)	2	38,500-78,400	1	48,900,000
C_0eːd	2	9,360-10,200	2	84,200-1,100,000
C_0oːt	2	21,900-147,000	1	204,000
C_0øːd	1	7,040	3	50,000-730,000
C_0Vdː	2	15,200-2,220,000	1	(very high frequency of participle sfx)

The following paragraphs will consider each stem type in turn. The label 'ineffable' is based on the judgments listed in *SAG* (1999:214).

The first case of unfaithful mapping that generates ineffability involves the mapping [ɑ] → [a]. This is a familiar source of ineffability in Swedish, recently discussed by Raffelsiefen 2002; a partial analysis is provided in Chapter 4 of the present thesis. Sometimes the alternations result in ineffability in neuter paradigms; sometimes they do not. Rare words suffer gaps in their paradigms; frequent words allow alternations in their paradigms. According to Raffelsiefen (2002:40) 'Hellberg (1974:204) blames the avoidance to the rareness of the alternation [,] Cederschiöld (1912:134) notes that the alternation…obscures the relation between the words….' Both Hellberg and Cederschiöld are correct: both alternation and frequency play a role. In the following chart, I have listed adjectives of the form C_0Vd and C_0Vt words from Allén et al. 1970-1980, a corpus of 1,000,000 words of newsprint. They are listed in order of the frequency of the plural form.[69] I have also listed the number of hits that the

[69] I have refrained from using lemma frequency, since it is inevitable that words featuring paradigm gaps will have lower total frequency, partially due to the paradigm

adjective has with the suffix –*a* on Google (April 20, 2010); the search is restricted to pages written in Swedish, but includes all homographic –a suffixes, including the definite form of the adjective (both singular and plural) and the indefinite plural. Inevitably, this also includes unrelated homographs.

(298)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[grɑːd]	INEFFABLE	'straight'	0	6980
[flɑːt]	INEFFABLE	'flat'	0	63,200
[lɑːt]	INEFFABLE	'lazy'	0	827,000
[glɑːd]	gl[a] + tː	'happy'	29	2,270,000

The words 'straight', 'flat', and 'lazy' are sufficiently rare that they are not listed in their plural form at all in Allén et al's 1970-1980 corpus; their frequency on Google is likewise relatively low. The word 'happy' is quite common, however, and its plural form was found 29 times in the corpus, and more than 2 million times in Google. Notice that ineffability and low frequency are correlated. The words with lowest frequency are the words that are ineffable in the neuter. The word with the highest frequency has an overt neuter form.

Notice that there is no phonotactic involved in this ineffability. The items [grɑːd] 'straight' and 'happy' [glɑːd] are near-minimal pairs, the only difference being the second element of the onset. There is no reason to assume that the difference between [l] and [r] in the onset should have implications for suffixation.

The correlation between low morpheme frequency and ineffability is not restricted to the mapping [ɑ] → [a]. The mapping [y] → [ʏ] also shows the correlation between ineffability and low frequency. Consider the three words:

---

gap itself. Notice that the plural form is never ineffable, so there is no circularity in the reasoning. The plural suffix is /a/.

(299)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[pryːd]	INEFFABLE	'prudish'	2	38,500
[kryː]	INEFFABLE	'healthy'	1	78,400
[nyː]	n[ʏ] + tː	'new'	577	48,900,000

The words 'prudish' and 'healthy' is somewhat rare; their plural indices in Allén et al.'s corpus are 2 and 1, respectively; they were attested in the –a form 38 500 and 78,400 times on Google. In contrast, the word 'new' is one of the most common adjectives of Swedish, and its plural form is attested 577 times in Allén et al., and more than 48,000,000 times on Google. The words 'prudish' and 'healthy' have no neuter form, but the word 'new' has a neuter form with a short lax vowel. The word with high frequency features an unfaithful mapping; the word with low frequency has a paradigm gap instead.

The tense [e] alternates with the lax vowel [ɛ̝], and the mapping between these vowels can also generate this kind of ineffability. Consider the four adjectives of Swedish with the structure C_0ed.

(300)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[vreːd]	INEFFABLE	'angry'	0	9,360
[çeːd]	INEFFABLE	'fed up'	0	10,200[70]
[sneːd]	sn[ɛ̝] + tː	'crooked'	2	84,200
[breːd]	br[ɛ̝] + tː	'broad'	16	1,100,000

The words 'angry' and 'fed up' have the lowest frequency; their plural form are not listed in Allén et al.; its –*a* form have around 10,000 hits on Google. The words 'crooked' and 'broad' are more common, with respective plural frequencies of 2 and 16

[70] The index is certainly smaller than this. The search engine found instances of 'Keda' that were personal names and acronyms.

in Allén et al. The *–a* form of these adjectives resulted in 84,200 and 1,100,000 hits on Google, respectively. The words with the lowest frequency are ineffable in the neuter; the words with a higher frequency have an overt neuter form.

The tense/lax mapping [o, ɔ] can likewise trigger ineffability. Consider the following words of the form C_0oːt.

(301)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[soːt]	INEFFABLE	'intimate'	0	21,900
[koːt]	INEFFABLE	'horny'	0	147,000[71]
[voːt]	v[ɔ] + tː	'wet'	2	204,000

As noted, low frequency is associated with ineffability; high frequency is associated with overt affixation.

Even the tense/lax mapping [ø, ø̞] can trigger ineffability. This is an interesting case, since the perceptual distance quite small.

(302)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[snøːd]	INEFFABLE	'sordid'	0	7,040
[sprøːd]	spr[ø̞] + tː	'crisp'	5	50,000
[røːd]	r[ø̞] + tː	'red'	574	520,000
[døːd]	d[ø̞] + tː	'dead'	307	730,000

The ineffable item is rare indeed; and more common words have overt forms.

The examples of unfaithful mapping that we have seen up to now feature unfaithful mappings among vowels. Recall, however, that voiced obstruents can become devoiced due to the affixation of the neuter suffix (Linell et al. 1971:105, Hellberg 1974:144, *SAG* 1999:211).

[71] The actual index is certainly smaller. The prevalence of sexual content on the internet provides an artificial boost to the word's frequency.

(303) = (296)

STEM	NEUTER	GLOSS
loː[g]	loː[g̊] + t	'low'

One case of a voiced obstruent resisting devoicing involves the geminate [dː]. When the stem ends in this sound, it is not only devoiced, but in fact deleted from the phonological representation altogether, since the neuter suffix [tː] cannot be preceded by another dental stop.[72] So, the relevant mapping is [dː] → ∅. It is familiar that the word [rɛdː] 'afraid' is ineffable in the neuter (Hellberg 1974, Eliasson 1975, Raffelsiefen 2002, McCarthy & Wolf 2005; Buchanan 2007), and the word [fadː] 'flat, stale' patterns the same way. Interestingly, when the geminate [dː] is the past participle, the deletion of the sound from the phonological representation is accepted, and does not trigger ineffability. While I lack a specific index for the participial suffix—Allén et al 1970-1980 does not list frequencies of suffixes—there is no doubt that the participial suffix has a much higher frequency than the morphemes 'flat, stale' or 'afraid'. In the following chart, the attestation of the unaffixed form was checked on Google instead of the –a form, since 'rädda' (afraid, pl) is homographic with the infinitive 'to save'.

(304)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE
fa[dː]	INEFFABLE	'flat, stale'	2 (of stem)	15,200
rɛ[dː]	INEFFABLE	'afraid'	24 (of stem)	2,220,000
se + [dː][73]	se + [∅] + tː	'see + prt.'	very high (of prt. sfx)	

Once again, ineffability as listed in *SAG* (1999) is correlated with lower frequency, and overt morphology is correlated with higher frequency.

[72] For a related effect in Japanese see Kawahara 2006.

[73] The crucial morpheme here is the participial suffix, not the stem /se + dː/. This is evident, since the participle never triggers ineffability in the neuter; the frequency of the stem is irrelevant to the calculation of overtness of participial forms, since they are always overt.

5.3 English Stress-shift and Frequency (Hammond 1999)

5.3.1 Background

We require a formalism for the ineffability/frequency correlation. The formalism will be derivative of Hammond 1999, so it is appropriate to introduce this work, and to discuss his formalism.

Hammond 1999 focuses on the phenomenon of stress-shift in English; in particular, the Rhythm Rule. It is a familiar fact of English that phrasal structure can trigger stress shift. While the word 'thirteen' has main stress on the second syllable in the isolation form, it has main stress on the first syllable in the phrase 'thirteen men':

(305) ISOLATION FORM thìrtéen

STRESS-SHIFT FORM thírtèen mén

This type of stress-shift, according to Hammond, is judged to be more acceptable with high-frequency words than with low-frequency words.

5.3.2 Hammond's formalism

Hammond 1999 focuses on the distinction between words of low frequency and words of high frequency. He compares the words 'antique', a word of relatively high frequency, to 'arcane', a word of relatively low frequency. Because of its high frequency, the word 'antique' can undergo stress-shift. Because of its low frequency, 'arcane' resists stress shift. Let us consider the constraints and rankings that Hammond 1999 uses to derive this fact.

The crucial constraints that Hammond uses are the following:

(306) *CLASH: avoid adjacent main stresses

ISOLATION-CONTEXT CORRESPONDENCE [c(X)]

The stress of context forms for some form X must mirror that of the isolation form of X.

Hammond's innovation lies in the ranking of c(X). The constraint's ranking depends on the word's frequency. Hammond (1999:354) notes that

> these constraints can be ranked differently with respect to *CLASH. Specifically, I propose that the ranking of ISOLATION-CONTEXT CORRESPONDENCE constraints mirrors the frequency of the associated item.

Since words 'arcane' and 'antique' have different frequencies, the constraint c(X) is ranked differently for the two words. In particular, c(*antique*) is ranked lower than *CLASH, whereas c(*arcane*) is ranked higher than *CLASH. Consider a tableau for 'antique book':

(307)

	/àntíque bóok/	c(*arcane*)	*CLASH	c(*antique*)
a. >	ántìque bóok			*
b.	àntíque bóok		*!	

The low ranking of c(*antique*) makes the stress-shift in candidate (a) the optimal candidate. Candidate (b), which is prosodically faithful but features stress-clash, violates the higher ranked *CLASH constraint.

Now, consider the tableau for ‘arcane sort’.

(308)

	/àrcáne sórt/	c(*arcane*)	*CLASH	c(*antique*)
a.	árcàne sórt	*!		
b. >	àrcáne sórt		*	

Here, the c(*arcane*) constraint is ranked higher than *CLASH; this rules out candidate (a), with stress-shift. Candidate (b), which is prosodically faithful but features stress-clash, is now the optimal candidate, because of the low ranking of *CLASH with respect to c(*arcane*).

Some details of Hammond’s account are not explicit. Hammond (1999:355) notes that

> the constraints corresponding to that item become lower-ranked and hence susceptible to more of the phonological generalizations of the language in question. While much remains to be worked out, this approach provides the beginnings of a plausible account of how language-specific constraints are incorporated into the constraint set.

What follows is an explicit formulation of the frequency-sensitive Rhythm Rule, which also can be used to handle the frequency-sensitive ineffability facts of Swedish.

5.3.3 A new formalism for Rhythm Rule

The formalism for the Rhythm Rule which we will set forth is based on the *MAP constraint of Zuraw 2007. The constraint rules out unfaithful mapping:

(309) =(222) ***MAP S_1S_2 ($^{A}X^{B}$, $^{C}Y^{D}$)** (Zuraw 2007)

an X in the environment A_B in string S_1 must not correspond to a Y in the environment C_D in string S_2.

Recall that this constraint also involves a principle that generates default constraint rankings:

(310) =(223) **Distance-to-ranking projection** (Zuraw p.c.)

If $\Delta(^{A}X^{B}, {}^{C}Y^{D}) > \Delta(^{A'}X'^{B'}, {}^{C'}Y'^{D'})$

then *MAP S_1S_2 ($^{A}X^{B}$, $^{C}Y^{D}$) $\gg$ *MAP S_1S_2 ($^{A'}X'^{B'}$, $^{C'}Y'^{D'}$)

Informally, greater perceptual distance in an unfaithful mapping results in a more severe penalty for the mapping.

The present innovation involves relativizing *MAP to frequency.

(311) ***MAP S_1S_2 (X, Y) (i)**

an X in a morpheme of frequency i in string S_1 must not correspond to a Y in string S_2.

This constraint also involves a novel mechanism that generates default constraint rankings, in addition to Zuraw's (2007) mechanism listed above. This mechanism will be central to subsequent discussion; it applies to equivalent mappings with different morpheme frequencies:

(312) **Frequency-to-ranking projection**

For any pair of morpheme frequencies i and j,

if $i < j$

then *MAP (X,Y) (i) $\gg$ *MAP (X,Y) (j).

Informally, an unfaithful mapping from X to Y in a less frequent morpheme is more severely penalized than an unfaithful mapping from X to Y in a more frequent morpheme. Note that this is not a system of lexeme-specific constraints. Ranking is

determined by a combination of correspondence and morpheme frequency. Two distinct lexemes with the same correspondence patterns and the same morpheme frequency would always be ranked the same way.

Let us return to the phrases ‘antique book’ and ‘arcane sort’. The CELEX lemma frequency (Baayen et al. 1995) for ‘arcane’ is 17; the one for ‘antique’ is 168. We are interested in mappings from the faithful second-syllable tonic ($_{|}\sigma\ldots{}^{|}\sigma$) to the stress-shifted first-syllable tonic (${}^{|}\sigma\ldots_{|}\sigma$). By the frequency-to-ranking projection mechanism, we obtain the relative rankings of the *MAP ($_{|}\sigma\ldots{}^{|}\sigma$, ${}^{|}\sigma\ldots_{|}\sigma$) constraints, relativized to the frequencies of ‘arcane’ and ‘antique’:

(313) if 17 < 168

then *MAP ($_{|}\sigma\ldots{}^{|}\sigma$, ${}^{|}\sigma\ldots_{|}\sigma$) (17) ≫ *MAP ($_{|}\sigma\ldots{}^{|}\sigma$, ${}^{|}\sigma\ldots_{|}\sigma$) (168)

If *CLASH is interleaved between the two *Map constraints, we generate the correct output. For ‘antique book’, the relevant *MAP ($_{|}\sigma\ldots{}^{|}\sigma$, ${}^{|}\sigma\ldots_{|}\sigma$) constraint is *MAP ($_{|}\sigma\ldots{}^{|}\sigma$, ${}^{|}\sigma\ldots_{|}\sigma$) (168), since the frequency of ‘antique’ is 168. For ‘arcane sort’, the relevant *MAP ($_{|}\sigma\ldots{}^{|}\sigma$, ${}^{|}\sigma\ldots_{|}\sigma$) constraint is *MAP ($_{|}\sigma\ldots{}^{|}\sigma$, ${}^{|}\sigma\ldots_{|}\sigma$) (17), since the frequency of ‘arcane’ is 17. Consider the tableau for ‘antique book’:

(314)

	àntíque bóok (Freq ‘ANTIQUE’ = 168)	*MAP ($_{|}\sigma\ldots{}^{|}\sigma$, ${}^{|}\sigma\ldots_{|}\sigma$) (17)	*CLASH	*MAP ($_{|}\sigma\ldots{}^{|}\sigma$, ${}^{|}\sigma\ldots_{|}\sigma$) (168)
a. >	ántìque bóok			*
b.	àntíque bóok		*!	

The frequency index 168 is part of the UR of ‘antique’. So, *MAP (ˌσ…ˈσ, ˈσ…ˌσ) (168) is the relevant constraint which penalizes unfaithful prosodic mapping in candidate (a). Since this constraint is ranked lower than *CLASH, candidate (a), with stress shift, is the optimal candidate.

Now, take ‘arcane sort’. The frequency index 17 is part of the UR of ‘arcane’.

(315)

		*MAP (ˌσ…ˈσ, ˈσ…ˌσ) (17)	*CLASH	*MAP (ˌσ…ˈσ, ˈσ…ˌσ) (168)
	àrcáne sórt (Freq ‘ARCANE’ = 17)			
a.	árcàne sórt	*!		
b. >	àrcáne sórt		*	

*MAP (ˌσ…ˈσ, ˈσ…ˌσ) (17) is the relevant constraint which penalizes unfaithful prosodic mapping in candidate (a). Crucially, this constraint is ranked higher than *CLASH, so candidate (a) is dispreferred, and candidate (b) is optimal.

5.4 Application of *MAP (i) to Swedish ineffable forms

5.4.1 Background

In section 5.1, we noted that the unfaithful mapping [ɑ] → [a] generates ineffability in words of low frequency:

(316) = (298)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[grɑːd]	INEFFABLE	‘straight’	0	6980

[flɑːt]	INEFFABLE	'flat'	0	63,200
[lɑːt]	INEFFABLE	'lazy'	0	827,000
[glɑːd]	gl[a] + tː	'happy'	29	2,270,000

Assuming that the relevant O-O mapping is [ɑ] → [a], the relevant *MAP constraint family is *MAP (ɑ, a).[74] By virtue of our frequency-to-ranking projection mechanism, the following rankings of *MAP (ɑ, a) constraints is derived. We will refer to the Google attestations as approximations for an actual frequency index.

(317) if 6980 < 63,200
then *MAP (ɑ, a) (6980) ≫ *MAP (ɑ, a) (63,200)

if 63,200 < 827,000
then *MAP (ɑ, a) (63,200) ≫ *MAP (ɑ, a) (827,000)

if 827,000 < 2,270,000
then *MAP (ɑ, a) (827,000) ≫ *MAP (ɑ, a) (2,270,000)

Putting these together, we generate the following rankings:

(318) *MAP (ɑ, a) (6980)
≫ *MAP (ɑ, a) (63,200)
≫ *MAP (ɑ, a) (827,000)
≫ *MAP (ɑ, a) (2,270,000)

[74] This is a simplification. Note that we also have the mappings from the coda [d] to ∅, and the mappings from the coda [t] to ∅. It is not obvious that these should be ranked equally. So perhaps 'happy' should only be compared to 'straight'; and 'lazy' and 'flat' should be isolated. I have put them all together, since there is no high frequency adjective (with an overt neuter form) with the rime [ɑːt], to compare 'lazy' and 'flat' with.

Some additional constraints are necessary for the construction of the tableaux. First, a phonotactic of Swedish stress is required: A syllable never has a long vowel followed by a long consonant.

(319) *V:C:

Second, A vowel is tense iff it is long.

(320) [+LONG] ⇔ [+TENSE]

The biconditional statement of the constraint rules out both tense short vowels and lax long vowels.

Third, a constraint rules out the degemination of the lexically moraic suffix after a stressed vowel.

(321) IDENT [Long C] / ˈV_

Fourth, a morphological representation requires a structural realization. The NULL PARSE candidate violates M-PARSE, but satisfies all other constraints (Prince & Smolensky 1993:2004).

Note that M-PARSE opens the door to an analysis where frequency-sensitive ineffability is driven by a family of M-PARSE constraints indexed to frequency, rather than having the faithfulness constraints indexed to frequency. I will assume that the frequency indices are associated to the faithfulness constraints, since this permits a formalism of the Ganong effect and frequency-sensitive flapping, discussed later in this chapter. Also, it appears that different tense/lax mappings (i.e., different perceptual distances) require different frequency indices to surmount ineffability. This is discussed below in section 5.4.3.

5.4.2 Tableaux

Consider some tableaux. Take the /grɑd + tː/, the neuter form of ‘straight’, where the stem has a frequency index of 6980:

(322)

/grɑ$_T$d + tː/ ‘straight, n.’ Cf. [grɑːd] (*Freq* /grɑd/ = 6980)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] /ˈV_	*MAP (ɑ, a) (6980)	*MAP (ɑ, a) (63,200)	*MAP (ɑ, a) (827,000)	M-PARSE	*MAP (ɑ, a) (2,270,000)
a. grɑː$_T$tː	*!							
b. grɑ$_T$tː		*!						
c grɑː$_T$t			*!					
d. gra$_L$tː				*!				
e. > ⊙							*	

Candidate (a), with faithful vowel quality and suffix length, is ruled out by the first constraint, since the SR is superheavy. Candidate (b), with a short but tense vowel, is ruled out by the second constraint: only long vowels are tense. Candidate (c) features a degeminated suffix, violating the constraint IDENT [Long C]. Candidate (d) features the *Map (ɑ, a) violation for the frequency index 6980, which is the frequency index of the stem in question. Candidate (d), with no phonological structure, violates M-PARSE. Crucially, *Map (ɑ, a) (6980) is ranked higher than M-PARSE, so the NULL PARSE candidate ‘⊙’ emerges as the optimal candidate.

The NULL PARSE candidate is also the optimal candidate for ‘flat, n.’

(323)

/flɑ$_T$t + tː/ 'flat, n.' Cf. [flɑːt] (*Freq* /flɑt/ = 63,200)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] /ˈV_	*MAP (ɑ, a) (6980)	*MAP (ɑ, a) (63,200)	*MAP (ɑ, a) (827,000)	M-PARSE	*MAP (ɑ, a) (2,270,000)
a. flɑːT$_T$tː	*!							
b. flɑ$_T$tː		*!						
c flɑːT$_T$t			*!					
d. fla$_L$tː					*!			
e. > ⊙							*	

The same mechanism generates the NULL PARSE candidate '⊙' for the tableau of 'lazy, n.'

(324)

/lɑ$_T$t + tː/ ‘lazy, n.’ Cf. [lɑːt] (*Freq* /lɑt/ = 827,000)	$\sigma_{\mu\mu}$ ↔ [+ stress]	[+ LONG] ↔ [+ TENSE]	IDENT [Long C] /ˈV_	*MAP (ɑ, a) (6980)	*MAP (ɑ, a) (63,200)	*MAP (ɑ, a) (827,000)	M-PARSE	*MAP (ɑ, a) (2,270,000)
a. lɑːT tː	*!							
b. lɑT tː		*!						
c lɑːT t			*!					
d. laL tː						*!		
e. > ⊙							*	

Candidates (a), (b) and (c) are ruled out for phonotactic reasons. Candidate (d) violates the *MAP constraint relativized to the appropriate frequency index. Crucially, this *MAP constraint is ranked higher than M-PARSE, so the NULL PARSE candidate ‘⊙’ emerges as optimal.

Note that the faithfulness constraints for frequency indices 6,980; 63,200; and 827,000 are not binned together in the present proposal. The constraints have different rankings, but produce similar outputs because of their identical rankings relative to M-PARSE.

Now take the tableau for ‘happy, n.’:

(325)

/glɑ$_T$d + tː/ ‘happy, n.’ Cf. [glɑːd] (*Freq* /glɑd/ = 2,270,000)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] /ˈV_	*MAP (ɑ, a) (6980)	*MAP (ɑ, a) (63,200)	*MAP (ɑ,a) (827,000)	M-PARSE	*MAP (ɑ, a) (2,270,000)
a. glɑːT tː	*!							
b. glɑT tː		*!						
c glɑːT t			*!					
d. glaL tː								*
e. > ⊙							*!	

Candidates (a), (b), and (c) are ruled out by the first two constraints, as above. Consider candidates (d) and (e). Since ‘happy’ has a frequency index of 2,270,000; it is susceptible to the constraint *MAP (ɑ, a) (2,270,000). This is ranked lower than M-PARSE, so now the NULL PARSE ‘⊙’ is no longer the optimal candidate. Rather, candidate (d), with the unfaithful vowel quality, emerges as the optimal candidate.

We can use the same mechanisms to generate the frequency-sensitive ineffability related to other tense/lax mappings. Take the mapping [y] → [Y]. Recall the frequency indices for the stems ‘prudish’, ‘healthy’, and ‘new’:

(326) = (299)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[pryːd]	INEFFABLE	'prudish'	2	38,500
[kryː]	INEFFABLE	'healthy'	1	78,400
[nyː]	n[Y] + tː	'new'	577	48,900,000

By virtue of the frequency-to-ranking projection mechanism, we obtain the following rankings within the constraint family *MAP (y, Y):

(327) if *Freq* (38,500) < *Freq* (78,400),
then *MAP (y, Y) (38,500) ≫ *MAP (y, Y) (78,400)

if *Freq* (78,400) < *Freq* (48,900,000),
then *MAP (y, Y) (78,400) ≫ *MAP (y, Y) (48,900,000)

Putting these together, we generate the following rankings:

(328) *MAP (y, Y) (38,500)
≫ *MAP (y, Y) (78,400)
≫ *MAP (y, Y) (48,900,000)

If M-PARSE is interleaved between *MAP (y, Y) (78,400) and *MAP (y, Y) (48,900,000), we generate the correct outputs:

(329)

/pry$_T$d + t:/ ‘prudish, n.’ Cf. [pry$_T$:d] (*Freq* /pryd/ = 38,500)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] /'V_	*MAP (y, Y) (38,500)	*MAP (y, Y) (78,400)	M-PARSE	*MAP (y, Y) (48,900,000)
a. pry$_T$:t:	*!						
b. pry$_T$t:		*!					
c. pry$_T$:t			*!				
d. prY$_L$t:				*!			
e. > ⊙						*	

Since *MAP (y, Y) (38,500) is ranked higher than M-PARSE, the NULL PARSE candidate ‘⊙’ is the optimal candidate.

The tableau for ‘healthy, n.’ works the same way:

(330)

/kry$_T$ + t:/ ‘healthy, n.’ Cf. [kry$_T$:] (*Freq* /kry/ = 78,400)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] /'V_	*MAP (y, Y) (38 500)	*MAP (y, Y) (78,400)	M-PARSE	*MAP (y, Y) (48,900,000)
a. kry$_T$:t:	*!						
b. kry$_T$t:		*!					
c. kry$_T$:t			*!				
d. krY$_L$t:					*!		
e. > ⊙						*	

Since *MAP (y, Y) (78,400) is ranked higher than M-PARSE, the NULL PARSE candidate '⊙' is the optimal candidate.

Now consider the input that is sensitive to *MAP (y, Y) (48,900,000):

(331)

/ny$_T$ + tː/ 'new, n.' Cf. [ny$_T$ː] (*Freq* /ny/ =48,900,000)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] /ˈV_	*MAP (y,Y) (38 500)	*MAP (y,Y) (78,400)	M-PARSE	*MAP (y,Y) (48,900,000)
a. ny$_T$ːtː	*!						
b. ny$_T$tː		*!					
c. ny$_T$ːt			*!				
d. > nY$_L$tː							*
e. ⊙						*!	

Since *Map (y,Y) (48,900,000) is ranked lower than M-PARSE, the candidate with unfaithful vowel quality is optimal.

The frequency-sensitive ineffability resulting from the mapping [e] → [ɛ̝] works the same way. Recall the data:

(332) =(300)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[vreːd]	INEFFABLE	'angry'	0	9,360
[çeːd]	INEFFABLE	'fed up'	0	10,200
[sneːd]	sn[ɛ̝] + tː	'crooked'	2	84,200
[breːd]	br[ɛ̝] + tː	'broad'	16	1,100,000

The frequency-to-ranking projection mechanism provides the following three rankings:

(333)

if	9,360	<	10,200
then	*MAP (e,ɛ̝) (9,360)	≫	*MAP (e,ɛ̝) (10,200)
if	10,200	<	84,200
then	*MAP (e,ɛ̝) (10,200)	≫	*MAP (e,ɛ̝) (84,200)
if	84,200	<	1,100,000
then	*MAP (e,ɛ̝) (84,200)	≫	*MAP (e,ɛ̝) (1,100,000)

Putting these together, we obtain the following ranking:

(334)

*MAP (e,ɛ̝) (9,360)

≫ *MAP (e,ɛ̝) (10,200)

≫ *MAP (e,ɛ̝) (84,200)

≫ *MAP (e,ɛ̝) (1,100,000)

Assuming that M-PARSE falls between *MAP (e,ɛ̝) (10,200) and *MAP (e,ɛ̝) (84,200), we can generate the appropriate outputs. Compare the tableau for 'fed up, n.' and 'crooked, n.':

(335)

/çe$_T$d +tː/ ‘fed up, n.’ Cf. [çe$_T$ːd] (*Freq* /çed/ = 10,200)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] / ˈV_	*MAP (e, ɛ) (10,200)	M- PARSE	*MAP (e, ɛ) (84,200)
a. çe$_T$ːtː	*!					
b. çe$_T$tː		*!				
c. çe$_T$ːt			*!			
d. çɛ$_L$tː				*!		
e. > ⊙					*	

M-PARSE is crucially ranked lower than *MAP (e,ɛ) (10,200), where 10,200 is the frequency index for the stem. So, the NULL PARSE candidate ‘⊙’ emerges as optimal.

Now consider the tableaux for ‘crooked, n.’:

(336)

	/sne$_T$d + tː/ ‘crooked, n.’ Cf. [sne$_T$ːd] (*Freq* /sned/ = 84,200)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] / [+]	*MAP (e, ɛ̣) (10,200)	M-PARSE	*MAP (e, ɛ̣) (84,200)
a.	sne$_T$ːtː	*!					
b.	sne$_T$tː		*!				
c.	sne$_T$ːt			*!			
d. >	snɛ̣$_L$tː						*
e.	⊙					*!	

M-PARSE is ranked higher than *MAP (e, ɛ̣) (84,200), where 84,200 is the frequency index for ‘crooked’. So, candidate (d), with unfaithful vowel quality, emerges as the optimal candidate in each tableau.

The mechanism also applies for the mapping [o] → [ɔ]. The mapping is acceptable if the word has a sufficiently high frequency index:

(337) = (301)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[soːt]	INEFFABLE	‘intimate’	0	21,900
[koːt]	INEFFABLE	‘horny’	0	147,000
[voːt]	v[ɔ] + tː	‘wet’	2	204,000

Compare the tableaux for ‘horny, n.’ and ‘wet, n.’:

(338)

	/ko$_T$t +tː/ ‘horny, n.’ Cf. [ko$_T$ːt] (*Freq* /kot/ = 147,000)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] / ˈV _	*MAP (o,ɔ) (147,000)	M- PARSE	*MAP (o,ɔ) (204,000)
a.	ko$_T$ːtː	*!					
b.	ko$_T$tː		*!				
c.	ko$_T$ːt			*!			
d.	kɔ$_L$tː				*!		
e. >	⊙					*	

The relevant *MAP constraint, relativized to the appropriate frequency index, is ranked higher than M-PARSE; so the NULL PARSE candidate emerges as optimal.

Contrast this with the tableau for ‘wet, n.’

(339)

	/vo$_T$t +tː/ ‘wet’ neut. Cf. [vo$_T$ːt] (*Freq* /vot/ =204,000)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] / ˈV _	*MAP (o,ɔ) (147,000)	M- PARSE	*MAP (o,ɔ) (204,000)
a.	vo$_T$ːtː	*!					
b.	vo$_T$tː		*!				
c.	vo$_T$ːt			*!			
d. >	vɔ$_L$tː						*
e.	⊙					*!	

Here the relevant *MAP constraint—now associated with a higher frequency index—is ranked lower than the M-PARSE constraint. So the overt output with unfaithful vowel mapping emerges as optimal.

Even the tense/lax mapping [ø] → [ø̞] triggers ineffability if the word has a sufficiently low frequency index:

(340)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[snøːd]	INEFFABLE	‘sordid’	0	7,040
[sprøːd]	spr[ø̞]+tː	‘crisp’	5	50,000
[røːd]	r[ø̞]+tː	‘red’	574	520,000
[døːd]	d[ø̞]+tː	‘dead’	307	730,000

The relevant vowel mapping involves the slight change [ø] → [ø̞]. When the word is sufficiently rare, this change generates ineffability. The mechanism is as above. Compare the tableaux for ‘sordid, n.’ and ‘crisp, n.’:

(341)

/snø$_T$d +tː/ ‘sordid, n.’ Cf. [snø$_T$ːd] (*Freq* /snød/ = 7,040)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] / ˈV _	*MAP (ø,ø̣) (7,040)	M- PARSE	*MAP (ø,ø̣) (50,000)
a. snø$_T$ːtː	*!					
b. snø$_T$tː		*!				
c. snø$_T$ːt			*!			
d. snø̣$_L$tː				*!		
e. > ⊙					*	

The *MAP constraint associated with the morpheme’s frequency index is ranked higher than M-PARSE, so the NULL PARSE candidate emerges as optimal.

Now consider the tableau for ‘crisp, n.’:

(342)

	/sprø$_T$d +tː/ ‘crisp, n.’ Cf. [sprø$_T$ːd] (*Freq* /sprød/ = 7,040)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] / ˈV _	*MAP (ø,ø̯) (7,040)	M- PARSE	*MAP (ø,ø̯) (50,000)
a.	sprø$_T$ːtː	*!					
b.	sprø$_T$tː		*!				
c.	sprø$_T$ːt			*!			
d. >	sprø̯$_L$tː						*
e.	⊙					*!	

Here, the relevant *MAP constraint is ranked lower than M-PARSE, so the overt neuter form is optimal.

5.4.3 Reference to specific vowels in ineffability

It is clear that reference to frequency is necessary to account for ineffability. However, we might ask whether we can bin together all the vowels together, and only refer to frequency to generate the ineffability. This would be simpler than the present proposal. It appears that this would not work, although it is difficult to be certain at this point. The reason is that the sources of the frequency index (Allén et al. 1970-1980 and Google) provide conflicting information.

Compare the words ‘crisp, n.’ and ‘lazy, n.’; and consider their frequency indices as listed on Google:

(343)

STEM	NEUTER	GLOSS	GOOGLE (-A)
[sprøːd]	spr[ø̞] + tː	'crisp'	50,000
[lɑːt]	INEFFABLE	'lazy'	827,000

The affixed form (ending in *–a*) is much higher for the word 'lazy' than for 'crisp', but 'lazy' is ineffable while 'crisp' is not ineffable. This is not merely the result of the verb *lata (sig)* 'to be lazy' being included in the tally: comparisons of the unaffixed forms resulted in 26,000 hits for 'crisp', compared to 953,000 hits for 'lazy'.

However, Allén et al. (1970-1980) suggests another story:

(344)

STEM	NEUTER	GLOSS	ALLÉN (PL-A)	(LEMMA)
[sprøːd]	spr[ø̞] + tː	'crisp'	5	10
[lɑːt]	INEFFABLE	'lazy'	0	5

Here, the frequency index appears to be higher for the overt word than for the ineffable word. Since Google and Allén et al (1970-1980) show conflicting information, it is difficult to be confident about the relative values for the crucial frequency indices; and therefore it is difficult to be confident about the need for reference to vowel quality in calculating ineffability.

Conflicting frequency indices also arise when we compare 'crooked, n.' (with an overt neuter form) and 'lazy, n.' (with an ineffable neuter form). The lemma frequency 'crooked' is higher than that of 'lazy':

(345)

STEM	NEUTER	GLOSS	ALLÉN (LEMMA)
[sneːd]	sn[ɛ̞] + tː	'crooked'	3
[lɑːt]	INEFFABLE	'lazy'	5

This is remarkable, since the paradigm gap in 'lazy' might be expected to pull down the total lemma frequency.

At first blush, it seems that the Google values of the affixed forms (ending in *–a*) conform to this pattern:

(346)

STEM	NEUTER	GLOSS	GOOGLE (-A)
[sneːd]	sn[ɛ̣] + tː	'crooked'	84,200
[lɑːt]	INEFFABLE	'lazy'	827,000

The verbal form *lata sig* 'to be lazy' is not responsible for the higher number of hits for 'lazy': the values of the unaffixed forms *sned* and *lat* are 156,000 and 958,000; respectively.

However, the Google values are quite different when we consider the values of the commonly *misspelled* unaffixed form *sne* with the correctly spelled *lat*:

(347)

ORTHOGRAPHY	GLOSS	GOOGLE (-A)
sne	'crooked'	1,230,000
lat	'lazy'	958,000

Now, the word with the overt neuter form, 'crooked', has a higher frequency index than the word with a paradigm gap, 'lazy'.

For the present study, we will assume that ineffability due to vocalic laxing requires reference to vowel quality. More reliable frequency information would be required to ascertain the claim.

5.4.4 Ineffability in iambs

Frequency also influences ineffability in prosodically marked words. The default foot in Swedish is the trochee (Riad 1992), but Latinate borrowings have provided the language with many iambs. These iambs are more resistant to shifts in tenseness than monosyllabic stems. Iambs and anapests that end in [ɑːt], [eːt], and [ʉːt] have haplological neuters.

(348)

STEM	NEUTER	GLOSS
[kɔŋˈkreːt]	HAPLOLOGICAL	‘concrete’
[dɪsˈkreːt]	HAPLOLOGICAL	‘discrete’
[aˈkʉːt]	HAPLOLOGICAL	‘acute’
[rəsɔˈlʉːt]	HAPLOLOGICAL	‘resolute’
[apsɔˈlʉːt]	HAPLOLOGICAL	‘absolute’
[adəˈkvɑːt]	HAPLOLOGICAL	‘adequate’
[dəliˈkɑːt]	HAPLOLOGICAL	‘delicate’
[dəspəˈrɑːt]	HAPLOLOGICAL	‘desperate’
[mʊdəˈrɑːt]	HAPLOLOGICAL	‘moderate’
[prɪˈvɑːt]	HAPLOLOGICAL	‘private’
[səpaˈrɑːt]	HAPLOLOGICAL	‘separate’
[kaˈvɑːt]	HAPLOLOGICAL	‘spirited’

This is the case, independent of morpheme frequency. Compare the two following pairs:

(349)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[koŋˈkreːt]	HAPLOLOGICAL	‘concrete’	25	1,110,000
[sneːd]	sn[ɛ̨] + tː	‘crooked’	2	84,200

(350)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[prɪˈvɑːt]	HAPLOLOGICAL	‘private’	35	3,080,000
[glɑːd]	gl[a] + tː	‘happy’	29	2,270,000

In these pairs, the monosyllabic stem has a laxed vowel in the neuter; but the iambic stem cirvumvents laxing by means of haplology. Note that the monosyllabic stem has a lower frequency than the iambic stem: we would expect the iambic stem to alternate

more readily than the monosyllabic stem, due to the influence of frequency on the ranking of faithfulness constraints. Something more than mere frequency is influencing the mapping: prosodic structure seems to play a role. Specifically, a given *MAP constraint relativized to a specific mapping and a specific frequency index in iambic stems is more highly ranked than the equivalent *MAP constraint in monosyllabic stems.

(351) *MAP (X, Y)/i/+IAMB ≫*MAP (X, Y)/i/-IAMB.

However, comparing among iambs (i.e., not mixing them with monosyllabic stems), the influence of frequency applies robustly. The following are iambic words listed in *SAG* 1999 that end in [iːd], listed in order of frequency:

(352)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
[pərˈfiːd]	INEFFABLE	'perfidious'	0	1,240
[stʉˈpiːd]	INEFFABLE	'stupid'	2	3,380
[tɪˈmiːd]	INEFFABLE	'timid'	1	5,350
[mɔrˈbiːd]	INEFFABLE	'morbid'	0	9,160
[hʏˈbriːd]	INEFFABLE	'hybrid'	0	16,800
[rɪˈgiːd]	INEFFABLE	'rigid'	0	29,300
[sʊˈliːd]	sʊl[ɪ]+tː	'solid'	7	70,400

Notice that only the word with the highest frequency has an overt neuter; the other words are ineffable.

Compare the tableaux for 'rigid, n.' and 'solid, n.':

(353)

/rɪgid +tː/ 'rigid, n.' Cf. [rɪgi$_T$ːd] (*Freq* /rɪgid / =29,300)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] / ˈV _	*MAP (i, ɪ) (29,300)/ +IAMB	M- PARSE	*MAP (i, ɪ) (70,400)/ +IAMB
a. rɪgi$_T$ːtː	*!					
b. rɪgi$_T$tː		*!				
c. rɪgi$_T$ːt			*!			
d. rɪgɪ$_L$tː				*!		
e. > ⊙					*	

The relevant *MAP constraint—relativized to frequency index and prosodic structure—is ranked higher than M-PARSE, so the NULL PARSE candidate emerges as optimal.

Compare the tableau for 'solid, n.':

(354)

/sʊlid +tː/ ‘solid, n.’ Cf. [sʊli$_T$ːd] (*Freq* /sʊlid / = 70,400)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] / ˈV _	*MAP (i,ɪ) (29,300)/ +IAMB	M- PARSE	*MAP (i,ɪ) (70,400)/ +IAMB
a. sʊli$_T$ːtː	*!					
b. sʊli$_T$tː		*!				
c. sʊli$_T$ːt			*!			
d. sʊlɪ$_L$tː						*
e. > ⊙					*!	

The morpheme ‘solid’ has a higher frequency, so the relevant *MAP constraint is ranked lower; in particular, it is ranked lower than M-PARSE, so the vowel surfaces as lax.

5.4.5 The mapping [dː]→ ∅

So far, we have seen how frequency (in addition to perceptual distance and prosodic structure) influences the ranking of faithfulness constraints (*MAP constraints, in particular) in tense/lax vowel pairs. When the relevant *MAP constraint is ranked higher than M-PARSE, ineffability results. The *MAP constraints generate ineffability in the mapping [dː] → ∅ in the same way. Recall the data:

(355) = (304)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE
fa[dː]	INEFFABLE	'flat, stale'	2 (of stem)	15,200
rɛ[dː]	INEFFABLE	'afraid'	24 (of stem)	2,220,000
se + [dː]	se + [∅] + tː	'see + prt.'	[very high frequency]	

The relevant *MAP family is *MAP (dː, ∅). The frequency-to-ranking projection mechanism generates the following rankings:

(356) if 15,200 < 2,220,000then

*MAP (dː,∅) (15,200) ≫ *MAP (dː,∅) (2,220,000)

if 2,220,000 < very high

then *MAP (dː,∅) (2,220,000) ≫ *MAP (dː,∅) (very high)

These two rankings imply the following ranking:

(357) *MAP (dː,∅) (15,200)

≫ *MAP (dː,∅) (2,220,000)

≫ *MAP (dː,∅) (very high)

If M-PARSE is interleaved between *MAP (dː,∅) (2,220,000) and *MAP (dː,∅) (very high), the correct outputs are generated. To rule out the fully faithful candidate, assume the ad hoc constraint SHARE VOICE:

(358) SHARE VOICE: Adjacent obstruents have the same value for the feature [voice].

Consider the tableaux for 'flat, n.' and 'afraid, n.':

(359)

/fadː +t:/ ‘flat, n.’ Cf. [fadː] (*Freq* /fadː/ =15,200)	SHARE VOICE	*MAP (dː,∅) (15,200)	*MAP (dː,∅) (2,220,000)	M-PARSE	*MAP (dː,∅) (very high)
a. fad:t:	*!				
b. fat:		*!			
c. > ⊙				*	

(360)

/rɛdː +t:/ ‘afraid, n.’ Cf. [rɛdː] (*Freq* /rɛdː/ =2,220,000)	SHARE VOICE	*MAP (dː,∅) (15,200)	*MAP (dː,∅) (2,220,000)	M-PARSE	*MAP (dː,∅) (very high)
a. rɛd:t:	*!				
b. rɛt:			*!		
c. > ⊙				*	

In both tableaux, candidate (a) is ruled out by the highly ranked SHARE VOICE. Candidate (b), with the unfaithful loss of the the geminate /dː/ from the representation, is ruled out, due to the high ranking of the constraints *MAP (dː,∅) (15,200) and *MAP (dː,∅) (2,220,000). The NULL PARSE candidate ‘⊙’ emerges as the optimal candidate.

Now take the tableau for ‘see, prt. n.’:

(361)

	/se +dː +tː/ ‘see, prt. n.’ Cf. [se +dː] (*Freq* /dː/ = very high)	SHARE VOICE	*MAP (dː,∅) (15,200)	*MAP (dː,∅) (2,220,000)	M-PARSE	*MAP (dː,∅) (very high)
a.	sedːt	*!				
b. >	setː					*
c.	⊙				*!	

*MAP (dː,∅) constraint is ranked lower than M-PARSE. Candidate (b), where the geminate is removed from the representation, emerges as the optimal candidate.

5.5 Paradigm gaps and frequency in Spanish

5.5.1 The pattern

The mechanism of *MAP relativized to frequency can be fruitfully used to generate frequency-sensitive ineffability patterns in Spanish (Albright 2003).

Albright 2003 draws attention to the fact that some Spanish verbal paradigms feature diphthongization. When the infinitive features a vowel [o] in the stem, the vowel alternates with the diphtong [we] when stressed. The verb *contar* ‘to count’ illustrates this:

(362) c[wé]nt-o c[o]nt-ámos
c[wé]nt-as c[o]nt-áis
c[wé]nt-a c[wé]nt-an

When the infinitive features a vowel [e] in the stem, the vowel alternates with the diphtong [je] when stressed. The verb *sentir* ‘to feel’ illustrates this:

(363)

s[jé]nt-o	s[e]nt-ímos
s[jé]nt-es	s[e]nt-ís
s[jé]nt-e	s[jé]nt-en

Some verbs feature paradigm gaps. Albright notes that the locus of the gaps is not haphazard. The verbs lacking all forms in which stress would fall on the root 'are missing forms where diphthongization and raising occur' (Albright 2003:4). Compare the verb *contar* (featuring no paradigm gap) with *abolir* (with four paradigm gaps). The loci of the gaps in *abolir* match the loci of diphthongization in *contar*:

(364)

	COSTAR 'COST'	ABOLIR 'ABOLISH'	
diphthong→	c[wé]st-o	INEFFABLE	←gap
diphthong→	c[wé]st-as	INEFFABLE	←gap
diphthong→	c[wé]st-a	INEFFABLE	←gap
	c[o]st-ámos	ab[o]l-imos	
	c[o]st-áis	ab[o]l-ís	
diphthong→	c[wé]st-an	INEFFABLE	←gap

There is good reason to assume that this phenomenon is comparable to the Swedish pattern discussed above. Just as ineffability in Swedish is associated with relatively low frequency, Albright (2003:4) states that 'most of the verbs that are claimed to have gaps are rare or archaic (including *abolir* itself).'

5.5.2 Ineffability and frequency in Spanish

A list of the verbs that feature diphthongization along with those with paradigm gaps shows a familiar scenario. The following items involving the actual or potential

mapping [o] → [we] are listed in the order of the frequency of the infinitive form[75], as listed in the Sebastián Gallés et al. 2000, a text corpus of approximately 5 million words.

(365)

INFINITIVE	1 P. SG.	GLOSS	LEXESP (INF)
col[o]rir	INEFFABLE	'color'	0
descol[o]rir	INEFFABLE	'de-color'	0
ab[o]lir	INEFFABLE	'abolish'	13
c[o]star	c[we]sto	'cost'	29
ll[o]ver	ll[we]vo	'rain'	39
dev[o]lver	dev[we]lvo	'return'	68
m[o]ver	m[we]vo	'move'	95
pr[o]bar	pr[we]bo	'try'	105
m[o]strar	m[we]stro	'show'	119
d[o]rmir	d[we]rmo	'sleep'	339
c[o]ntar	c[we]nto	'count'	364
rec[o]rdar	rec[we]rdo	'remember'	396
m[o]rir	m[we]ro	'die'	412
enc[o]ntrar	enc[we]ntro	'meet'	568
v[o]lver	v[we]lvo	'turn, become'	676
p[o]der	p[we]do	'can'	2193

Two of the words that Albright 2003 lists as ineffable (*colorir*, and *descolorir*) are sufficiently rare so as to not be listed in listed in Sebastián Gallés et al. 2000.

[75] I chose the infinitive form rather than the lemma, since the paradigm gap will inevitably reduce the total lemma frequency.

5.5.3 Projections and tableaux

Consider how the mechanism of *MAP relativized by frequency generates the distinct patterns of *abolir* (with paradigm gaps) and *costar* (with diphthongization). Assume that the relevant constraint family is *MAP (o,we). The frequency-to-ranking mechanism generates distinct *MAP (o,we) constraints for the two frequency indices, associated with the respective stems.

(366) if 13 < 29

then *MAP (o,we) (13) ≫ *MAP (o,we) (29)

If M-PARSE is ranked between these two constraints, we can generate the correct outputs. Consider a tableau for /abol + o/[76] 'abolish, 1 p. sg.':

(367)

/abol + o/ 'abolish 1p. sg.' (*Freq* 'abolir' = 13)	*'C_0o/1 P.SG.	*MAP (o, we) (13)	M-PARSE	*MAP (o, we) (29)
a. ab[o]lo	*!			
b. ab[we]lo		*!		
c. > ⊙			*	

Since M-PARSE is ranked lower than *MAP (o,we) (13), the NULL PARSE candidate is more optimal than the diphthongal candidate.

Now consider the tableau for /cost + o/ 'count, 1 p. sg.'

[76] I assume that the UR of the stem vowel is /o/, since ineffability never occurs in those forms with the [o] output. It seems intuitive that the grammar favors faithful mappings and disfavors unfaithful mappings.

(368)

	/cost + o/ 'cost 1p. sg.' (*Freq* 'costar = 29)	*'C_0o/1 P.SG.	*MAP (o, we) (13)	M-PARSE	*MAP (o, we) (29)
a.	c[o]sto	*!			
b. >	c[we]sto				*
c.	⊙			*!	

Since the stem has a higher frequency index, it has a lower ranked *MAP (o, we) constraint. Its index is 29, so the relevant constraint is *MAP (o, we) (29). This constraint is ranked lower than M-PARSE; the diphthongal candidate (b) is the output form.

The same mechanism can be used to formalize ineffability generated by the unfaithful mapping [e] → [je]. The following chart features words that either feature paradigm gaps or [je]-diphthongization, in order of frequency, as listed in the Sebastián Gallés et al. 2000.

(369)

INFINITIVE	1 P. SG.	GLOSS	LEXESP (INF)
agu[e]rrir	INEFFABLE	'prepare for battle'	0
arr[e]cirse	INEFFABLE	'stiffen'	0
at[e]rirse	INEFFABLE	'be numb'	0
den[e]grir	INEFFABLE	'blacken'	0
emped[e]rnir	INEFFABLE	'harden'	0
agr[e]dir	INEFFABLE	'assault'	6

transgr[e]dir	INEFFABLE	'transgress'	6
pref[e]rir	pref[je]ro	'prefer'	27
m[e]ntir	m[je]nto	'lie'	51
enc[e]nder	enc[je]ndo	'ignite'	82
n[e]gar	n[je]go	'deny'	84
com[e]nzar	com[je]nco	'begin'	158
def[e]nder	def[je]ndo	'defend'	165
c[e]rrar	c[je]rro	'close'	197
qu[e]rer	qu[je]ro	'want'	295
emp[e]zar	emp[je]zo	'begin'	303
s[e]ntir	s[je]nto	'feel'	314
ent[e]nder	ent[je]ndo	'understand'	430
p[e]rder	p[je]rdo	'lose'	444
p[e]nsar	p[je]nso	'think'	846

The frequency-to-ranking projection mechanism ensures that the stems with higher frequencies have lower-ranked *MAP (e, je) constraints:

(370) if 6 < 27

then *MAP (e, je) (6) ≫ *MAP (e, je) (27)

The tableaux are similar to those above.

5.6 Paradigm gaps and frequency in Russian

5.6.1 The pattern

In the present section, we will attempt to apply the mechanism of *MAP relativized to frequency to the paradigm gaps in Russian resulting from paradigmatic

stress-attraction to the stem. The relevant phenomenon is the ineffable genitive plural forms, as discussed by Pertsova 2005. While it seems initially to be a promising approach, it appears that further issues are involved, and *MAP relativized to frequency would need to be augmented by some additional apparatus.

There is a class of nouns in Russian, called 'end-stressed nouns'. These nouns are generally stressed on the suffix, not on the stem. The stems *kočerg* 'firepoker' and *poxval* 'praise' are two examples of such end-stressed nouns. Compare the paradigms of these two words:

(371)

		KOČERG 'FIREPOKER'	POXVAL 'PRAISE'	
NOM SG		*kočerg-á*	*poxval-á*	
GEN SG		*kočerg-í*	*poxval-y'*	
DAT SG		*kočerg-é*	*poxval-é*	
ACC SG		*kočerg-ú*	*poxval-ú*	
INSTR SG		*kočerg-ój*	*poxval-ój*	
PREP SG		*kočerg-é*	*poxval-é*	
NOM PL		*kočerg-í*	*poxval-y'*	
GEN PL	gap→	INEFFABLE	*poxvál-∅*	←stressed stem
DAT PL		*kočerg-ám*	*poxval-ám*	
ACC PL		*kočerg-í*	*poxval-y'*	
INSTR PL		*kočerg-ámi*	*poxval-ámi*	
PREP PL		*kočerg-áx*	*poxval-áx*	

Note that the words pattern in a parallel fashion, with one important difference: *kočerg* is ineffable in the genitive plural, whereas *poxval* has stress fall on the stem in the genitive plural.

5.6.2 End-stressed nouns from Pertsova 2005

Pertsova 2005 points out that this is the unique part of the paradigm with a stressed stem, and explains the paradigmatic gap as a reflex of Lexical Conservatism (Steriade 1994). Pertsova (2005:24) notes that the analysis of ineffability due to Lexical Conservatism 'predicts that any end-stressed noun that expects to select a null genitive plural allomorph will instead have a gap.' Of course, not all forms have such a gap: *poxval* does not, as noted. The following list is from Pertsova 2005, ordered by the frequency of the singular form, as listed in the Russian National Corpus[77] (`www.ruscorpora.ru`).

(372)

NOM SG	GEN PL	GLOSS	FREQ SG
brjuzg-á	INEFFABLE	'a squeamish person'	68
xurm-á	INEFFABLE	'persimmon'	94
čadr-á	INEFFABLE	'type of veil'	105
dud-á	INEFFABLE	'pipe' (coll)	191
jul-á	INEFFABLE	'top'	252
kajm-á	INEFFABLE	'edging'	282
fat-á	INEFFABLE	'bridal veil'	284
bald-á	INEFFABLE	'idiot (coll)	295
korčm-á	INEFFABLE	'tavern' (old)	302
konur-á	INEFFABLE	'doghouse'	375
kočerg-á	INEFFABLE	'firepoker'	386
sum-á	INEFFABLE	'pouch' (old)	545

[77] As far as I can tell, this corpus is an ongoing project, and has no specified author or year.

taxt-á	INEFFABLE	'type of couch'	631
mol'b-á	INEFFABLE	'entreaty'	926
kum-á	INEFFABLE	'child's godmother'	1140
bašk-á	INEFFABLE	'head'	1632
kišk-á	*kišók*	'intestine'	1651
poxval-á	*poxvál*	'praise'	1716
dug-á	INEFFABLE	'arc'	1970
kazn-á	INEFFABLE	'treasury'	2734
borod-á	*boród*	'beard'	6888
polos-á	*polós*	'stripe'	7076

The present thesis claims that ineffability is the result of *MAP constraints relativized to frequency, with the ineffable/overt divide being represented by the ranking of M-PARSE. If this approach is correct, all the ineffable forms should cluster together, and there should not be overlaps, as with the words 'arc' and 'treasury' above, which are flanked by explicit forms, although they are listed as ineffable in the genitive plural. I consulted with a Russian colleague, and asked for his intuitions about ineffability in the paradigms. While he generally agreed with Pertsova's data, my Russian consultant rejected the data for 'arc' and 'treasury'. The word 'arc' has an overt genitive plural in his dialect, and he claims that 'treasury' is a mass noun, and therefore lacks all plural forms.[78] Assuming this to be accurate, all of the ineffable forms cluster together, with an index of 1632 or lower. All overt genitive plurals cluster together, with an index of 1651 or higher. The clustering together of ineffable forms at lower word frequencies looks similar to the patterns noted above in Swedish and Spanish.

[78] Furthermore, *baška* 'head' has an overt plural in his dialect, and he speculates that *kuma* 'godmother' may lack a plural for independent reasons.

5.6.3 End-stressed nouns not included in Pertsova 2005

If one considers a larger list of end-stressed words, however, the pattern no longer holds. The following list includes some end-stressed nouns not included in Pertsova 2005; the frequency index is again from the Russian National Corpus.

(373)

NOM SG	GEN PL	GLOSS	FREQ SG
zurn-á	*zúrn*	'musical instrument'	33
pial-á	*piál*	'bowl'	150
kljuk-á	*kljúk*	'walking stick'	177
jul-á	INEFFABLE	'top'	252
fat-á	INEFFABLE	'veil'	284
kum-á	INEFFABLE	'child's godmother'	1140
dug-á	*dúg*	'arc'	1970
graf-á	*gráf*	'facet'	15832

The words are ordered by frequency, but the overt forms and the ineffable forms are interleaved; this is exactly what we predict should not happen.

*MAP constraints relativized by frequency, with frequency projecting the ranking of the constraint lets us capture the patterns of frequency-sensitive ineffability in Swedish and Spanish; Russian end-stressed nouns remain unexplained by the mechanism.

5.7 Two clarifications regarding the frequency index

The preceding sections has illustrated how frequency indices can be incorporated directly into the grammar (for another approach see Coetzee 2009). If this approach is

on the right track, two related questions come to mind. First, is it computationally feasible to add these indices? Second, what is a frequency index?

Several scholars have expressed to me their reservations about the computational cost of adding frequency indices. The issue is that of infinity: given that the numbers are infinite, it seems to follow that indices are infinite. Since every index is associated with a distinct constraint (i.e., there is no binning together of similar frequencies), the number of constraints is infinite. This seems like a high price to pay for the analysis of a handful of ineffable forms.

This concern is not as grave as it may first appear. While the system has been made richer, it has not been made infinitely richer. This is so, for reasons that Zhang (2007) discusses, in the context of perceptual constraints. Zhang (2007:445) notes that ranked perceptual constraints penalize deviations from the input 'only…when they cross a particular perceptual threshold; otherwise they do not incur faithfulness violations.' Indiscriminable candidates are 'learned as one' (Zhang 2007:449). In Zhang's constraint-domination approach, constraints refer to integer-numbers of steps along a perceptual scale, rather than to continuous values; step size is determined by the smallest perceptible difference on that scale.

The same applies to frequency indices. The way that morpheme frequency is stored in the grammar is an empirical matter; but the system may well be discrete and finite. Furthermore, the system is presumably logarithmic, a detail neglected in the formalism above. Presumably, the difference between frequency 0 and 1 is significant to the grammar; it seems less obvious that the difference between 2000 and 2001 should be significant to the grammar. This latter pair may be 'learned as one', to use Zhang's phrase. Just as Zhang refers to a perceptual threshold for sound differences, the grammar assigns frequency indices by means of principles of frequency perceptibility.

That is, indices are integer-numbers of steps along a frequency scale, rather than to continuous values; where step size is determined by the smallest perceptible difference in morpheme frequency.

So, what is a frequency index? For the study above, I referred to two sources to establish morpheme frequency, namely Allén et al. (1970-1980) and Google. To be frank, there is no reason to assume that human grammar features the exact frequency representations that these sources have. Setting aside the inevitable questions of bias, there is a general issue of morpheme frequency that has been neglected: it seems that frequency effects involve expectations from interlocutors, rather than raw frequency numbers. An example will illustrate my point. Having grown up in the United States, I have developed the habit of pronouncing my last name in the American fashion, as [lɑfstɛt]. While my name is quite banal in Sweden, it is very exotic to Americans. In particular, the cluster [fst] is very rare in English, and the name's internal morphological structure is opaque to Americans. To make sure that people understand my name accurately, I tend to hyperarticulate it whenever I pronounce it in English. I do not hyperarticulate it when I speak Swedish, since there is no danger of misunderstanding. In my own lexicon of English, my last name must have a reasonably high frequency: it comes up in any bureaucratic circumstance I may find myself in. But phonologically, I treat it as a very rare word (i.e., I hyperarticulate it), since I assume that it is a novel word to the rest of the American community. So while the actual frequency of the item is rather high in my own lexicon, the index assigned to it in my grammar is very low. This illustrates that a frequency index is more abstract than raw frequency: it is an estimate of the word's frequency for our interlocutors.

For this reason, it may well be the case that a better gauge of a morpheme's grammatical frequency index would involve psycholinguistic data, where subjects are

simply asked to guess how frequent such-and-such a word is in their community, or for 'a typical speaker'. Perhaps different indices are assigned to different social contexts and registers, resulting in different phonological effects in these contexts and registers.

5.8 Psycholinguistic motivation for *MAP relativized by frequency

5.8.1 Frequency and perceptibility

We have seen that high morpheme frequency results in low rankings of *MAP constraints. It has long been known that frequency and perceptibility are related. Broadbent (1967:1) notes that

> The fact that common words are, other things being equal, more easily perceived is perhaps only a special case of the general influence of probability on perception.

The author notes that the relation goes beyond language (Broadbent 1967:1):

> From the time of the classic experiments on distortion in perception and remembering…it has been common ground to most psychologists that a probable event is easily perceived.

Lexical access is easier if a word is more common. Whaley 1978 established faster reaction times for frequent items in lexical decision, and Forster & Chambers 1973 established faster reaction times for frequent items in naming tasks. Bybee (2001:6) notes that

> [h]igh-frequency words and phrases have stronger representations in the sense that they are more easily accessed ….. Low-frequency words are more difficult to access….

Since high-frequency words are more easily accessed, less information is needed to trigger their access. Flemming (2007:3) makes the following observations:

> It is very well established that more frequent words are identified more rapidly and accurately…. In terms of Bayesian analysis, higher frequency of a word *w* implies a higher prior probability of that word, *p(w).* Accordingly less bottom-up evidence is required to reach a given threshold probability and reaction times are faster.

Two classic experiments illustrate the influence of word frequency on perception. Broadbent (1967) compared the accuracy of perception between pairs of words in noise, where one word of each pair was a high frequency item (frequency of at least 100 per million words) and the other word was not a high frequency item (frequency of 10-49 per million words). Correct responses for high frequency words exceeded that of non-high frequency words. Broadbent (1967:13) notes that 'the word-frequency effect is markedly present, amounting to a difference in probability of correct responses of about .2.' Broadbent (1967:13) claims that 'the effect is due to a prior bias in favor of common words, which combines with sensory evidence favoring the objectively correct word.'

Ganong (1980) established a similar bias, when subjects were exposed to phonetically ambiguous stimuli. In the experiment,

> acoustic continua varying in voice onset time were constructed so that for each acoustic continuum, one of the two possible phonetic categorizations made a word and the other did not. For example, one continuum ranged between the word *dash* and the nonword *tash*; another used the nonword *dask* and the word *task*. (Ganong 1980:1)

The subjects tended to classify these ambiguous stimuli in a way that generated lexical items:

> In the two experiments, subjects showed…a tendency to make phonetic categorizations that make words. This lexical effect was greater at the phoneme boundary (where auditory information is ambiguous)…. (Ganong 1980:1)

This can be interpreted as a frequency effect, since words of zero frequency (nonce words) were more difficult to perceive than words of non-zero frequency (real words).

5.8.2 Formalism for Ganong effect

We might formalize the Ganong effect by means of perception tableaux (Boersma 1998). Take the perceptually ambiguous stimuli dash/tash. The item 'dash' is a real word, and its frequency index in CELEX (Baayen et al. 1995) is 231; the item 'tash' is a non-word, so it has a frequency index of 0. These frequency indices are relevant to the frequency-to-ranking projection mechanism. Assume furthermore that the constraint family *MAP ([t,d], /t/) (which maps a stimulus intermediate between [t] and [d] to the phoneme /t/) is ranked at the same level as *MAP ([t,d], /d/) (which maps a stimulus intermediate between [t] and [d] to the phoneme /d/). The frequency indices then generate the following ranking:

(374)	if	0	<	231
	then	*MAP ([t,d], t) (0)	≫	*MAP ([t,d], d) (231)

This ranking lets us construct a perception tableau, of the type constructed by Boersma 1998. The inputs are ambiguous stimuli; the candidates are the percepts.

(375)

	[t,d]ash (*Freq* 'TASH' = 0) (*Freq* 'DASH' = 231)	*MAP ([t,d], /t/) (0)	*MAP ([t,d], /d/) (231)
a.	/t/ash	*!	
b. >	/d/ash		*

Because the item 'tash' has a lower frequency, the stimulus-to-percept mapping is more costly. Because the item 'dash' has a higher frequency, the stimulus-to-percept mapping is less costly.

A similar tableau can be constructed to account for the task/dask stimulus. With the same assumptions as above, we can generate the following perception tableau:

(376)

	[t,d]ask (*Freq* 'DASK' = 0) (*Freq* 'TASK' = 1484)	*MAP ([t,d], /d/) (0)	*MAP ([t,d], /t/) (1484)
a. >	/t/ask		*
b.	/d/ask	*!	

The mechanism is just like the one we saw above. Because the item 'dask' has a lower frequency, the stimulus-to-percept mapping is more costly. Because the item 'task' has a higher frequency, the stimulus-to-percept mapping is less costly.

5.9 Extension: Flapping and frequency[79]

5.9.1 Background

Relativizing *MAP to frequency allows for insightful analyses of frequency-sensitive ineffability; it also allows for insightful analysis of frequency-sensitive phonetic effects.

Flapping, like other post-lexical rules, has few exceptions. It is however the case that flapping does not apply in rare words. Bybee (2001:67) notes that

> Exceptions to phonetic processes occur in low-frequency words, words perceived as foreign or highly formal, and, in some cases, where morphological relations restrain ongoing change […]. Thus it is said that words such as *veto* and *vita* are exceptions to English flapping….

5.9.2 Formalism for flapping

Consider how our mechanisms might capture this striking fact. Take the rare technical word 'vita' and the familiar name 'Rita'. While I have no reliable statistic for these items, it is safe to assume that 'vita' has a lower frequency than 'Rita'. Assume also that both have /t/ as the intervocalic consonant in UR. Then *MAP (t, ɾ) is the relevant constraint family, and the frequency-to-ranking projection mechanism provides distinct rankings for the two *MAP (t, ɾ) constraints:

(377)	if	*Freq* 'vita'	<	*Freq* 'Rita'
	then	*MAP (t.ɾ) (*Freq* 'vita')	≫	*MAP (t.ɾ) (*Freq* 'Rita')

Suppose now that the constraint that rules out the fully faithful intervocalic /t/—call it *ˈVtV— is interleaved between the two constraints, such that we have the ranking

[79] For further phonetic effects driven by frequency, see the probabilistic account of probabilistic phenomena in Coetzee (2009).

*MAP (t.ɾ) (*Freq* 'vita') ≫ *ˈVtV≫*MAP (t.ɾ) (*Freq* 'Rita'). This ranking lets us generate the faithful [t] in 'vita', while generating the intervocalic flap in 'Rita':

(378)

	/vitə/ (*Freq* 'vita' = lower)	*MAP (t.ɾ)/ (*Freq* = lower)	*ˈVtV	*MAP (t.ɾ)/ (*Freq* = higher)
a. >	vitə		*	
b.	viɾə	*!		

(379)

	/ritə/ (*Freq* 'Rita' = higher)	*MAP (t.ɾ)/ (*Freq* = lower)	*ˈVtV	*MAP (t.ɾ)/ (*Freq* = higher)
a.	ritə		*!	
b. >	riɾə			*

The unfaithful /t/-to-flap mapping is grammatical in the word of higher frequency; it is ungrammatical in the word of lower frequency.

5.10 Previous accounts of Swedish ineffability and exceptions to it[80]

5.10.1 Raffelsiefen 2002 on [ɑ]~[a] ineffability

Raffelsiefen 2002 provides an account for the difference in treatment between [grɑːd] 'straight', with an ineffable neuter form; and [glɑːd] 'glad', with the overt neuter form [glatː]. As discussed in Chapter 4, she follows Elert 1979 in assuming that the mapping from [ɑ] to [a] violates OO IDENT [back], which is crucially ranked above M-PARSE. This yields an ineffable neuter for [grɑːd] 'straight'.[81] In contrast,

> gl[atː] differs from gr[atː] in that it occurs independently in the paradigm of the corresponding utrum [i.e., , non-neuter] form: it is the supine of the related verb glädja 'to make happy'.

Raffelsiefen notes that

> [t]he winning candidate violates constraint OO IDENT [±back] with respect to the adjective [glɑːd], but satisfies OO IDENT [±back] …with respect to the supine form [glatː].

The crucial assumption is that the neuter adjective has access to the supine form in its evaluation.

There are two reasons to doubt this approach. First, the neuter adjective is distinct from the verbal form in meaning. For example, one can refer to *ett glatt leende* 'a happy smile', where the adjective has no verbal meaning associated with it (the smile was not made happy, for example). To be fair, however, it should be noted that Raffelsiefen is not committed to a verbal interpretation of the neuter adjective.

---

[80] Kiefer 1970 and Linell 1972 provide abstract morphological accounts, where the relevant word is given the feature [-Inflectable] (Kiefer 1970) or [-[-utrum, -pl]] (Linell 1972). I will presently focus on phonological accounts, rather than morphological accounts.

[81] Recall from chapter 3 that Raffelsiefen also has a constraint against minimality, motivated by her assumptions of syllable structure, which are not relevant to the issue at hand.

Second, the approach fails to capture the other cases of frequency-triggered overtness. Recall the following forms, which have overt neuter forms, due to their high frequency.

(380)

STEM	NEUTER	GLOSS
n[yː]	n[ʏ] + tː	'new'
sn[eː]d	sn[ɛ̝] + tː	'crooked'
[voːt]	v[ɔ] + tː	'wet'
[sprøːd]	spr[ø̝] + tː	'crisp'

We noted other words with the same rimes that were were ineffable. However, the words above are not homophonous with supine forms.

5.10.2 Accounts of ineffability of 'afraid, neuter'

Recall that the neuter of adjectives ending in [dː] is also systematically ineffable: The words [fadː] 'flat, stale' and [rɛ̝dː] 'afraid' have no neuter. Eliasson 1975 captures this fact by stipulating a constraint /*dd + D/, ruling out the suffixation of a dental consonant to a word ending in geminate /dː/. This is observationally adequate but fails to provide deeper insight into the phenomenon.

Raffelsiefen 2002 claims that this gap is the result of OO IDENT [LONG], stating that '[c]onsonants in derived forms must be identical to the corresponding long consonants in the base.' This fails to permit cases of devoicing in the neuter, in examples such as the following, where the geminates are devoiced: (Linell et al. 1971:105, Hellberg 1974:144, *SAG* 1999:211):

(381)

STEM	NEUTER	GLOSS
sny[gː]	sny[g̊ː] + t	'tidy'
sna[bː]	sna[b̥ː] + t	'fast, quick'

McCarthy and Wolf (2005) rule out the neuter of 'afraid' by having OCP and Uniformity ('no coalescence') ranked higher than M-PARSE, which is indexed to the relevant grammatical category:

(382)

	rɛdː$_3$ + t$_4$ 'afraid, n.'	OCP	UNIFORMITY	M-PARSE (ADJ-N-SING)
a. >	⊙			*
b.	rɛdː$_3$t$_4$	*!		
c.	rɛtː$_{3,4}$		*!	

All else being equal, this approach incorrectly predicts a NULL PARSE for all [d]-final adjectives in the neuter, including stems ending in singleton [d]. The following is a tableau illustrating the generation of the neuter form of [røːd] 'red', which has an overt neuter form [rø̞tː].

(383)

	rød$_3$ + t$_4$ ‘red, n.’	OCP	UNIFORMITY	M-PARSE (ADJ-N-SING)
a. 💣	⊙			*
b.	rød$_3$t$_4$	*!		
c. >	røt:$_{3,4}$		*!	

It is not rare for words ending in singleton [d] to generate overt neuters:

(384)

STEM	NEUTER	GLOSS
[bre:d]	[brɛ̝t:]	‘broad’
[dø:d]	[dø̝t:]	‘dead’
[rø:d]	[rø̝t:]	‘red’
[sprø:d]	[sprø̝t:]	‘crisp’
[gu:d]	[gɔt:]	‘good’
[sne:d]	[snɛ̝t:]	‘crooked’
[vi:d]	[vɪt:]	‘white’
[bli:d]	[blɪt:]	‘mild’
[soli:d]	[solɪt:]	‘solid’

The pattern is clear and systematic.

Buchanan (2007) approaches the ineffable neuter for ‘afraid’ in a fashion that is similar to Raffelsiefen’s, discussed above. The crucial constraint is IDENT-IO [GEMINATE], which states that

Input and output geminate correspondents must

- have the same value of the feature [voice]

- not be coalesced
- not share features with adjacent segments (Buchanan 2007:17)

This generates the ineffable NULL PARSE output for the word 'afraid':

(385)

/rädd + t/ 'afraid, n.'	OCP (COR)	ID-IO [GEM]	M-PARSE
a. räddt	*!		
b. rätt		*!	
c. > ⊙			*

As noted, it incorrectly rules out devoicing of geminate obstruents with overt neuter forms (Linell et al. 1971:105, Hellberg 1974:144, *SAG* 1999:211). :

(386) = (381)

STEM	NEUTER	GLOSS
sny[gː]	sny[g̊ː] + t	'tidy'
sna[bː]	sna[b̥ː] + t	'fast, quick'

Buchanan also provides a problematic account for the difference between the participle, which surfaces overtly in the neuter form. He crucially assumes that the participial suffix is singleton /d/, and is rendered long by virtue of coalescence with a preceding /d/. The following is his tableau for the neuter participle of [reːda] 'prepare':

(387)

/red + d + t/ ‘prepare, prt n’	OCP (COR)	ID-IO [GEM]	M-PARSE
a. reddt	*!		
b. > rett			
c. ⊙			*!

According to Buchanan, the constraint IDENT-IO [GEMINATE] does not apply, since there is no geminate in the UR.

This crucial assumption is incorrect. The participle is a geminate suffix, and the long consonant is not the result of coalescence with a preceding geminate, but surfaces in vowel-final stems, as discussed in Chapter 3.

(388)

STEM	PARTICIPLE	GLOSS
[truː]	[trʊdː]	‘believe’
[floː]	[flɔdː]	‘flay’
[flyː]	[flʏdː]	‘flee’
[ɧeː]	[ɧɛ̝dː]	‘occur’
[strøː]	[strø̞dː]	‘sprinkle’

Furthermore, the neuter suffix is also geminate in UR, as the following data illustrate:

(389)

STEM	NEUTER	GLOSS
[bloː]	[blɔtː]	‘blue’
[groː]	[grɔtː]	‘grey’
[friː]	[frɪtː]	‘free’

[nyː]	[nʏtː]	'new'
[sløː]	[sløt̩ː]	'lazy'

These suffixes are geminate in UR. Their length is not the result of coalescence: recall from Chapter 3 that it is simply not the case that a sequence of identical consonants triggers gemination in Swedish. If a singleton consonant is suffixed after a singleton stem-final consonant, the result is a *singleton* consonant. This was illustrated with the present tense suffix /r/ and the genitive /s/.

This being the case, Buchanan's account fails to predict the correct outcome in the case of neuter participles, which involve the suffixation of two geminate suffixes: (390)

/tru + dː + tː/ 'believe, prt n'	OCP (COR)	ID-IO [GEM]	M-PARSE
a. truddtt	*!		
b. > trutt		*!	
c. 💣 ⊙			

Buchanan's (2007) account predicts that the neuter participle should be ineffable, since it is geminate in UR; but it is not ineffable. Candidate (b) is the surface form.

5.11 Comparisons to Pinker 1984 and Bybee 2001

The present account is of course not the first attempt at considering exceptional morphophonological patterns associated with words of high frequency. The proposals of Pinker 1984 and Bybee 2001 merit discussion and comparison.

5.11.1 Pinker 1984

Pinker 1984 discusses the phenomenon of blocking, as driven by frequency. Accessing an irregular form involves accessing a representation in memory; this represses the application of the regular rule. This blocking assumes a specific grammatical architecture. In particular, words and rules are accessed in parallel. This specific architecture seems promising for the case that Pinker discusses: it seems reasonable that an overt exceptional form blocks an overt regular form.

Notice that the ineffability patterns that were discussed above constitute a different situation. Here a lack of an output—the NULL PARSE candidate '⊙'—blocks the application of a regular rule. It is not obvious how the NULL PARSE candidate should block the application of the rule. Also, to turn the problem on its head, it is not obvious how the stop the NULL PARSE candidate from blocking rule application in words of high frequency.

5.11.2 Bybee 2001

Bybee 2001 provides a usage-based account of phonology, and some points of comparison are in order. The frequency effects that Bybee focuses on involve reduction of form, and she ties reduction of form directly to frequency. Bybee (2001:8) makes the direct connection between repetition and reduction:

> Repetition leads to reduction of form. […] Greetings become reduced, (*how are you* becomes *hi*), grammaticizing phrases with increasing frequency reduce and compress (*going to* becomes *gonna*)….

Bybee focuses on reductive patterns, so she claims that 'structural properties are…derived from usage…' (Bybee 2001:110) The claim is accurate, as long as the 'structural properties' are precisely reductive properties. The frequency-sensitive

ineffability of Swedish and Spanish—where forms change from INEFFABLE to OVERT due to high frequency—cannot trivially be derived from 'usage' (except in the trivial sense of the notion).

Another important difference between Bybee's usage-based account and the present account of frequency-sensitive effects involves the locus of the sound-change in the architecture of the speaker. For Bybee (2001:61), the reduced form is in lexicon, not in grammar.

> The development of special phonological properties in high-frequency words and phrases entails two properties of language: first, that high levels of use lead to reduction and, second, that such reduction, as specific to these items, must be represented as part of their stored image.

We might contrast this with the present proposal, where phonological frequency effects are in the grammar, as an index on faithfulness constraints.

5.11.3 A novel usage-based proposal

One might suggest a usage-based approach to the facts of Swedish, if one assumes that the difference between the paradigms that have overt forms and those that have gaps involves access (or non-access) to listed forms, such that 'happy' has the listed neuter form /glatː/, but 'straight' lacks the listed neuter form /gratː/. Then a constraint such as USELISTED (Zuraw 2000) might rule out the NULL PARSE in the former, but not in the latter. USELISTED states that 'the input portion of a candidate must be a single lexical entry' (Zuraw 2000:50).

(391)

	‘glad, n.’ Cf. [glɑːd] Listed: /glatː/	USELISTED	*MAP (ɑ,a)	M-PARSE	*MAP (o,ɔ)
a.	/glɑd + tː/→[glatː]	*!	*		
b. >	/glatː/→[glatː]		*		
c.	⊙	*!		*	

(392)

	‘straight, n.’ Cf. [grɑːd] Listed: ∅	USELISTED	*MAP (ɑ,a)	M-PARSE	*MAP (o,ɔ)
a.	/grɑd + tː/→[gratː]	*	*!		
b. >	⊙	*		*	

In the case of non-problematic vowel-alternations, the relevant faithfulness constraint is simply ranked lower than M-PARSE, such that the faithful candidate emerges as optimal:

(393)

	‘blue, n’ Cf. [bloː] Listed: ∅	USELISTED	*MAP (ɑ,a)	M-PARSE	*MAP (o,ɔ)
a. >	blɔtː	*			*
b.	⊙	*		*!	

This usage-based approach makes different predictions than the grammatical approach above, where all the forms are generated by the grammar, without listing. In the usage-based approach, a language learner cannot innovate the neuter form, since the listing must be established in the ambient language (i.e., it must be 'listed'). In the grammatical approach above, however, an unattested neuter form can be innovated independent of diachronic establishment. Probing this empirical difference is a non-trivial matter. However, I have isolated one item of Swedish which may have changed from ineffable to overt within one generation. The data are inconclusive, but worthy of reflection. Holmes & Hinchliffe (2003:64) list the word *pigg* 'brisk' as ineffable in the neuter. Interestingly, this word also has the lowest frequency in the plural form in Allén et al (1970-1980) among adjectives ending in geminate [gː].

(394)

STEM	NEUTER	GLOSS	ALLÉN (PL)
pi[gː]	INEFFABLE	'brisk'	0
ɧy[gː]	ɧy[ɡː] + t[82]	'shy'	1
sny[gː]	sny[ɡː] + t	'tidy'	3
try[gː]	try[ɡː] + t	'safe'	5

Perhaps the judgment of ineffability is linked to its low frequency.

Strikingly, the word appears to have increased in frequency in the last 15 years. The form of the adjective 'brisk' with the /a/ suffix (plural and definite singular/plural) is now more common than the adjective 'shy'. The number of attestations of the *–a* form of the relevant adjectives on Google is as follows:

[82] Recall from chapter 3 that the suffix is degeminated after a consonant; see Teleman 1969 for discussion.

(395)

STEM	GLOSS	GOOGLE (-A)
pi[gː]	‘brisk’	243,000
ɧy[gː]	‘shy’	39,400
sny[gː]	‘tidy’	3,590,000
try[gː]	‘safe’	852,000

Notice that the frequency of ‘brisk’ is more than 6 times higher than the frequency of ‘shy’. Along with this increased frequency, it also appears that the neuter is no longer ineffable. The neuter form of ‘brisk’, written *piggt*, is attested 51,500 times on Google.[83]

I am reluctant to amplify the significance of one datum with a frequency of 1 in Allén et al. (1970-1980)’s corpus of only 1,000,000 words. Clearly, further examples of this type of phenomenon should be considered before jumping to conclusions about speakers’ capacity to innovate paradigmatic forms that are not listed in the ambient language. Nevertheless, the example is suggestive.

The usage-based approach and the grammatical approach also make different predictions if the frequency of a lemma falls dramatically within one generation of speakers. In such a case, the usage-based approach predicts maintenance of an overt form, since the diachronically established listing will presumably remain at least for one generation of speakers. According to the grammatical account, paradigm gaps are directly related to frequency, so a fall in a morpheme’s frequency can directly result in a paradigm gap; no diachronically established listings leave their residue in this account. Again, probing this question empirically is not an easy matter.

[83] There is no homograph in Swedish.

5.12 Local summary

I have presented an account of frequency-sensitive ineffability, according to which a morpheme's frequency index is part of its UR. The ranking of faithfulness constraints depends on this frequency index. According to this approach, frequency effects are part of the grammar proper—the constraint system—rather than some extragrammatical performance system.

6 Experiments

6.1 Introduction

This chapter describes the structure and results of five experiments, whose goal was to assess the validity of the P-maps in chapters 1 through 4. The experiments involve detection of [n] in various contexts; distinguishing [ən] from [an] and from [ɔn]; repetition blindness triggered by [ənən], [anən], and [ɔnən]; perceptibility of degemination; and perceptual distances between vocalic tense/lax pairs.

6.2 Detection of [n] : Method

6.2.1 Introduction

Recall from Chapter 1 that the realization of the Swedish definite article /n/ depends on the stem-final segment: if the stem ends in a vowel, there is generally no epenthesis before the suffix; if it ends in a lateral, there is metrically conditioned epenthesis; and if it ends in a nasal, there is obligatory epenthesis. It was argued that epenthesis served to render the nasal suffix perceptually salient.

To test whether the sound [n] differed in perceptibility depending on whether the preceding sound was a nasal, a lateral, or vowel, an AX discrimination task was prepared, featuring three conditions. Participants indicated by a mouse click whether the pair of tokens just heard were the same word or different words.

6.2.2 Stimulus preparation

The stimuli were recorded by three native speakers of Swedish in the Los Angeles area. The identified themselves as native speakers of Swedish in a pre-recording questionnaire, and they spoke the language fluently in interactions with the experimenter.

Nonsense words featuring each of the three conditions were recorded. These nonsense words were constructed by combining attested rimes with attested onsets, resulting in unattested words. For the post-nasal condition, the rimes [ʏmn], [ɛ̞mn], [ø̞mn], [amn], [aŋn], [ʏŋn], [ɵŋn], and [ɛ̞ŋn] are attested in the lexicon, as are the minimally different rimes with no final [n]: [ʏmː], [ɛ̞mː], [ø̞mː], [amː], [ʏŋː], [aŋː], [ɵŋː], and [ɛ̞ŋː]. The test items were constructed using these rimes with attested onsets. For the post-lateral condition, the rimes [ɑːln] and either [oːln] or [ɔln] (depending on dialect of the subject) are attested. So test items were constructed using these rimes with attested onsets. Also, the attested rimes without a wordfinal [n] were used: [ɑːl], and either [oːln] or [ɔlː]. For the post-vocalic condition, the rimes [iːn], [yːn], [eːn], [øːn], [ɛːn], [ʉːn], [uːn], [oːn], and [ɑːn] are all attested; as are the rimes without the final [n]: [iː], [yː], [eː], [øː], [ɛː], [ʉː], [uː], [oː], and [ɑː]. The test-items were constructed using these rimes, combined with attested onsets, resulting in nonce words. There were 12 'same' items in each condition, and 12 'different' items in each condition. With 3 conditions, that gives 72 total test items.

The stimulus speakers uttered the nonsense words (based on orthographic cues) in the frame sentence 'It was _____ I said' (Swedish: De' va' _____ ja' sa'). This ensured a uniform prosodic contour for each item. The speakers were recorded in a soundproof booth using PCQuirer software on a Dell Optiplex 170L computer and a Shure SM10a headworn microphone.

The items were edited out of the carrier sentence; the full nasal closure was included in all nasal-final items; the release of the nasal's oral closure was not part of any edited token.

After recording was done, the average intensity of each speaker's utterances was set at 70 dB. This was done on PRAAT software (Boersma & Weenink 2008), by using the commands Modify: Scale Intensity.

Since the carrier sentence has a high front glide [j] after the sample word, there was some [j]-coloring on the second half of the vowel-final items. The [j]-colored portion of the vowel was edited out, and the remaining first part was lengthened by using 'duration points' in PRAAT software. They were lengthened to a duration that sounded natural. Also the sound quality was checked for naturalness.

There were 24 pairs in each condition; among those 24, 12 of the pairs were 'same'; 12 were 'different'. Half of the pairs in the nasal condition featured a coda nasal [m]; half featured a coda nasal [ŋ]. [84]

The MATLAB program randomized the order of the elements of each pair. The order among the pairs was also randomized. The ratio same/different was 1:1. Among the same stimuli, half lacked a final [n], and half featured a final [n]. Among the 'different' stimuli, the order of the stimuli were randomized, so that half of the time the first item featured the final [n], and the second item lacked the final [n]; half of the time the order was the opposite.

6.2.3 Testing procedure

The test was run on 16 individuals in Los Angeles area, who identified themselves in a pre-experiment questionnaire as being native speakers of Swedish. They also identified themselves as not having any hearing disabilities or disabilities in their hands and fingers (to click on a mouse).

---

[84] The paired stimuli are listed in appendix 12.

The test was run using MATLAB software on a Dell Latitude D810 laptop computer, with Sony MDR-V200 headphones and a Logitech corded USB optical mouse with two buttons (left and right).

To ensure that the task was non-trivial, different voices were paired in the test items. With three voices recorded, there were three different pairs. This ensured that the task involved matching phonological representations, rather than merely matching phonetic impressions. With the order of the items randomized, this provided six different voice/order combinations.

Five trivially 'same' items were added; five trivially 'different' items were added. The trivially 'same' items were in fact the identical sound-file. The trivially 'different' items were totally unrelated tokens, with different consonants or different stressed vowels. These were added as a criterion to reject subjects who were not paying attention. It was decided that a minimum of 90% accuracy among these items would be necessary to be included in the analysis. No subject was in fact rejected in this experiment.

The output volume on the computer was set at maximum for all subjects. The tests were run in quiet places with minimal noise or disturbance: sometimes a soundproof booth in the UCLA Psycholinguistic Lab was used, but sometimes a quiet room in the subject's home was used.

Subjects were given instructions (in Swedish) to press a button on a mouse marked 'SAME WORD' (Swedish: 'SAMMA ORD') if they heard two voices say the same word; and to press a button marked 'DIFFERENT WORDS' (Swedish: 'OLIKA ORD') if they heard two voices say different words. Subjects were asked to work as quickly and accurately as possible. These instructions were written on the computer screen, and were also read aloud. Subjects were instructed to hold the mouse with both

hands, and use their thumbs to click on the buttons. To circumvent a bias of right/left-handedness resulting in skewed RTs, the association with the left button or right button with 'SAME WORD' was altered between subjects, so for 50% of the subjects it was associated with the left button, and for 50% with the right button. The Swedish phrases 'SAMMA ORD' and 'OLIKA ORD' were taped to the mouse buttons, and the phrases also appeared on the screen on the right or left side, respectively, matching the ordering on the mouse buttons.

The MATLAB software recorded the response (same/different) given by the subject, and also recorded the RT, starting from the end of the second item of each pair.

6.2.4 A complication in the stimuli

As noted, there is dialect variation among the lateral-n rimes; the crucial word is spelled *moln*, and means 'cloud'. This is a very common word (it is not technical or rare; any weather forecast would feature it multiple times), but its rime is hapax. In some dialects, it is pronounced with the rime [oːln] and in other dialects the rime is pronounced [ɔln]. To make sure that people were only tested on words with rimes attested in their dialect, two lists were prepared for words in the lateral-n condition. Half of the items on these two lists were identical: the rimes [ɑːl] and [ɑːln] are always phonotactically acceptable (there is no variability in the pronunciation of the word [ɑːln] 'ell'). However, the second half of the lists were different, depending on whether the subject pronounced the word 'cloud' as [moːln] or as [mɔln]. For speakers who pronounce 'cloud' as [moːln], nonsense words with the rimes [oːl] and [oːln] were recorded. For speakers who pronounce 'cloud' as [mɔln], nonsense words with the rimes [ɔlː] or [ɔln] were recorded. There were, then, two versions of the perception test. Before taking the test, subjects were asked to read aloud a text about clouds, where the

relevant word appeared several times.[85] Depending on their pronunciation of the word, they took the version of the perception test featuring the [oːl] and [oːln] rimes, or the version with the [ɔlː] and [ɔln] rimes. There were 9 subjects who took the test with the [oːl] and [oːln] rimes, and there were 7 who took the test with the [ɔlː] and [ɔln] rimes.

6.2.5 Practice trials and test trials

Nine practice trials were given—three from each condition (AA, BB, AB)—with answers given. These did not include 'trivially same' or 'trivially different' items.

The test items—excluding the practice trials—were run three times, with new randomizations of order (both within pairs and among pairs) each time. The tokens used in the practice trials were not used in the actual test. There were 72 different test trials total; since the test was run 3 times, there were 72x3 = 216 total test items.

(396)

	N_	L _	V_
same	12	12	12
different	12	12	12

x 3 blocks
x 16 subjects

This experiment was run in tandem with the other experiments discussed below. There was no break in the test.

[85] This is included as appendix 13.

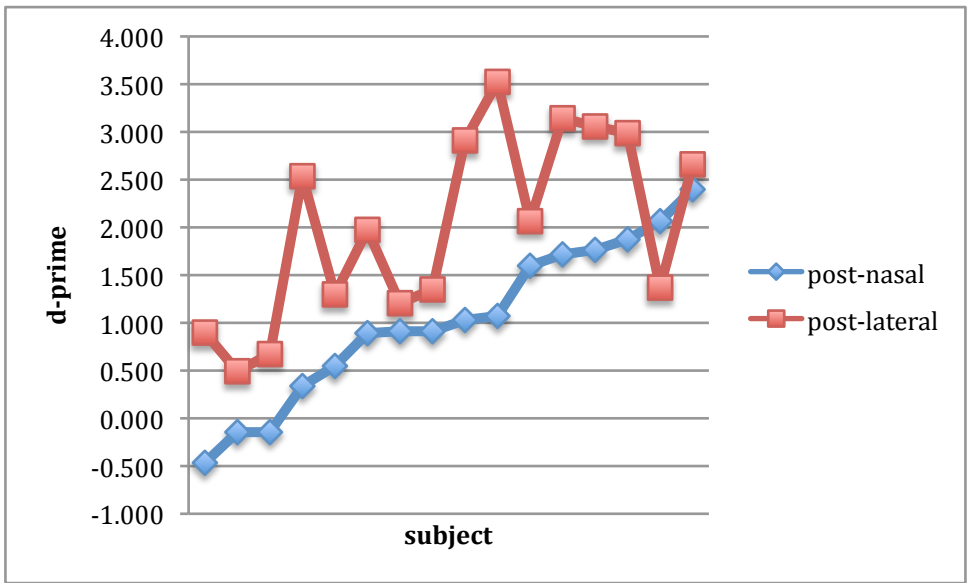
6.3 Detection of [n]: Results and discussion

6.3.1 d′ analysis

The sensitivity index d′ (Macmillan & Creelman 2005) provides the separation between the means of signal and noise distributions. A higher d′ indicates that a signal can be more readily detected. The signal detection of the presence of [n] in three conditions was analyzed, to determine the detectability of the ∅/n difference in each context (after a nasal, after a lateral, and after a vowel). For the present study, the equation for d′ that was used was the difference between the z-transform of the Hit Rate and the z-transform of the False Alarm Rate ($d' = z(H) - z(F)$). The mean d′ (averaging over subjects) for the post-nasal condition was 1.023; for the post-lateral condition it was higher, at 2.009; for the post-vocalic condition it dipped to 1.878. The reason for the dip in the post-vocalic condition will be discussed below. The ceiling d′ was 4.405.

A repeated measures ANOVA was performed on the data, using Stata software. The independent variable was context. There were three levels: post-nasal, post-lateral, and post-vocalic. The dependent variable was d′, the sensitivity index. The omnibus test resulted in $F(2,30) = 18.67$; $p < 0.001$. The difference between the post-nasal condition and the post-lateral condition resulted in $t(30) = 5.63$; $p < 0.001$; $\alpha = .017$, with a Bonferroni adjustment. The following graph illustrates the result, with the 16 subjects on the x-axis, and their d′ values for the two conditions on the y-axis. This graph, and subsequent graphs, are organized such that one of the variables is in increasing order (here, the d′ values in the post-nasal condition).

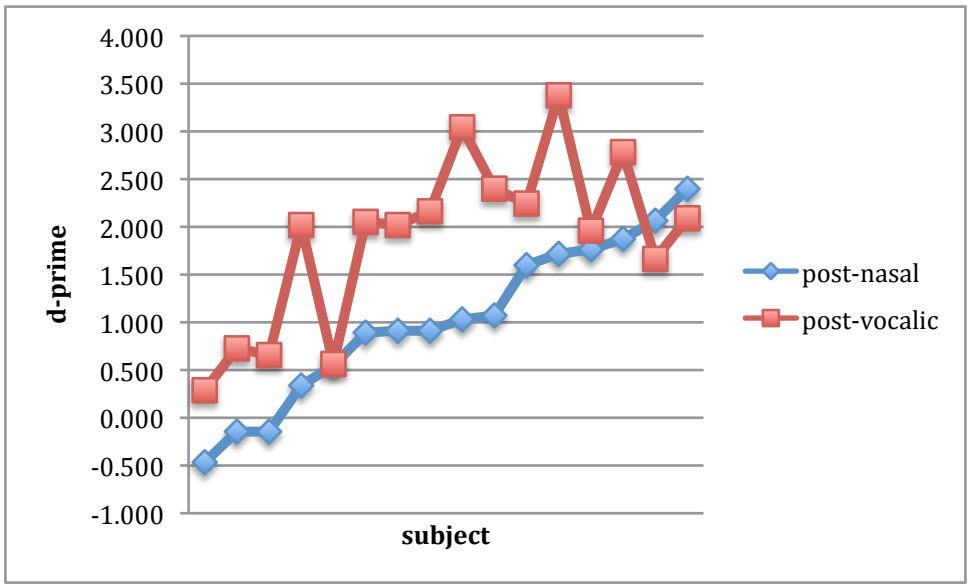
(397)



Note that the d′ for the post-lateral condition is almost always higher than that of the post-nasal condition. The nasal is easier to hear after a lateral than after another nasal.

The difference in signal detection between the post-nasal condition and the post-vocalic condition was also highly significant, with $t(30) = 4.88$; $p < 0.001$; $\alpha = 0.017$, with a Bonferroni adjustment.

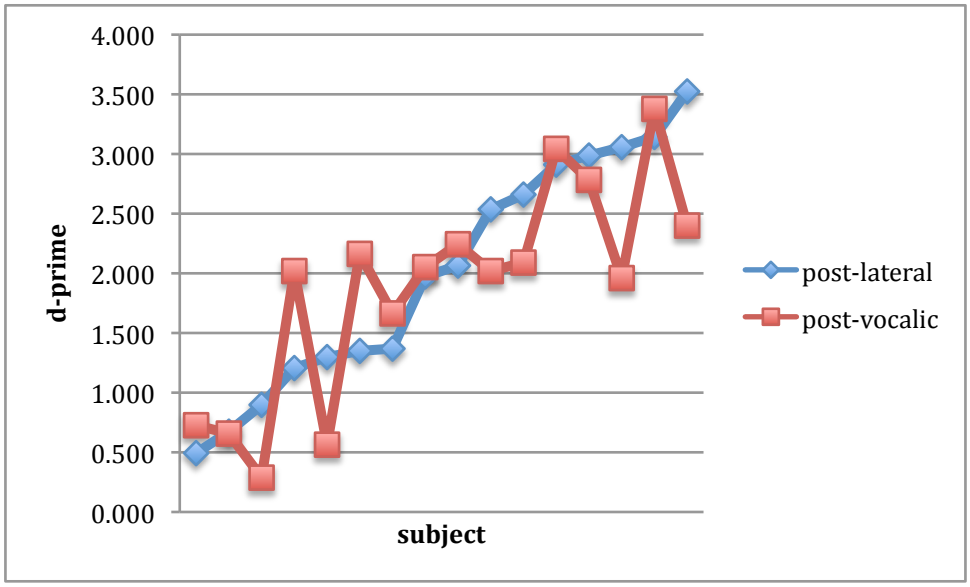
(398)



The d′ value of the post-vocalic condition is almost always higher than that of the post-nasal condition. It is easier to detect an [n] after a vowel than after a nasal.

The difference between the post-lateral condition and the post-vocalic condition, with $t(30) = 0.75$, was nonsignificant; $p = 0.461$; $\alpha = 0.017$, with a Bonferroni adjustment.

(399)



This is, then, a null result. It was assumed that the nasal would be easier to perceive after vowel than after a lateral; thereby explaining why there is generally no epenthesis after a vowel, but conditional epenthesis after a lateral.

There are two potential reasons for this unexpected result; both are errors in experiment design. First, there was a task-related confusion. Recall that different voices were used in the same/different task; no test items featured the same voice. This resulted in confusion on the part of the subjects, such that they attended to minute phonetic differences between the voices and their different dialects. So, the number of false alarm 'different' responses was amplified in the post-vocalic condition, because it was precisely in the post-vocalic condition that dialect differences were most prominent: this condition, in contrast to the other conditions, only featured long vowels. The other conditions, with short vowels, did not reveal as much dialect variation.

This is not mere speculation. Several subjects, upon completing the task, pointed out that the speakers had different dialects. One subject was convinced that this

dialect variation was the point of the exercise (he claimed this explicitly after he was done), and his false alarm rate in the post-vocalic condition (where dialect variation was most obvious) was 25.7%. In contrast, his false alarm rate in the post-lateral condition was 1.4%. A better experiment design would use speakers of the exact same dialect for all of the stimuli.

A further issue that favored the high accuracy in the post-lateral condition was the vowels in this condition: they were limited to [oː] or [ɔ], as well as [ɑː]. The word-final nasal spreads its nasalization leftward to the vowel, and these vowels, being non-high, carry nasalization very clearly (Beddor 1993). That means that the cue for the presence/absence of a word-final nasal could be noted well before the nasal consonant was actually pronounced. In contrast, the words in the post-vocalic condition included [iː] and [yː]. These high front vowels do not carry nasalization so clearly. One subject even noted that the Stockholm [iː] always sounded to her like it is followed by [n] (that is, it sounded nasal to her), so she found this task difficult.

A better experiment design would limit the vowels in the post-vocalic condition to [oː] and [ɑː], so that there is no difference in the ability for the vowels to cue nasality in the post-lateral condition and in the post-vocalic condition.

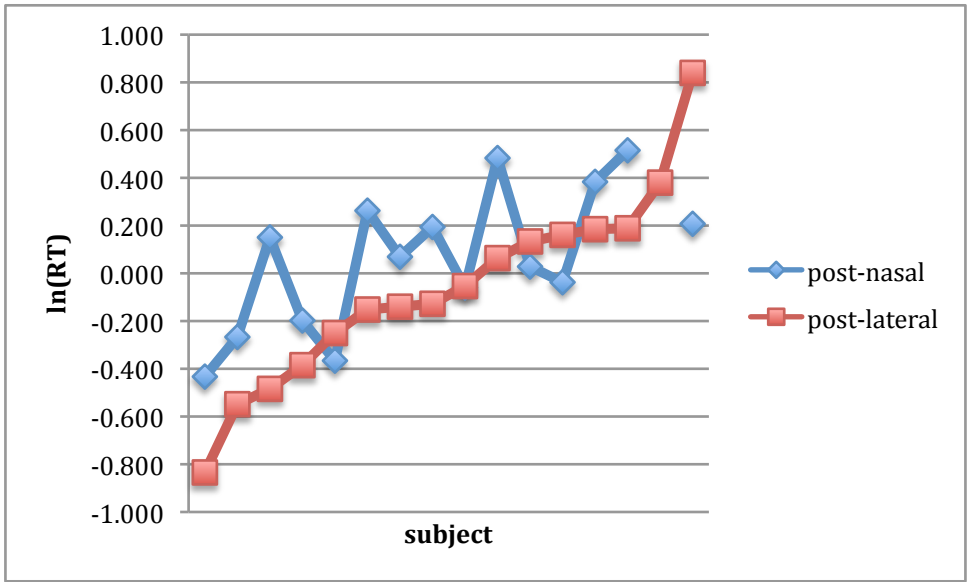
6.3.2 Reaction time analysis

The experiment on the perceptibility of [n] in the post-nasal, post-lateral, and post-vocalic condition was also analyzed in terms of the natural logarithm of RTs on correct answers in the 'different' condition. After discarding ln(RT)s that were more than 2 standard deviations from the mean, the mean ln(RT) in the post-nasal condition was .062 (=1064 msec.); the mean ln(RT) in the post-lateral condition was -0.064 (=938 msec.), and the mean ln(RT) in the post-vocalic condition was -0.231 (=794

msec.) A repeated measures ANOVA was applied to the results, using Stata software. The independent variables were context (three levels: post-nasal, post-lateral, and post-vocalic), and the dependent variable was ln(RT). An omnibus test resulted in $F(2,29) = 12.21$, with $p < 0.001$.

Comparing the post-nasal condition and the post-lateral condition resulted in $t(29) = -2.39$; $p = 0.023$, with $\alpha = 0.017$, with a Bonferroni adjustment.

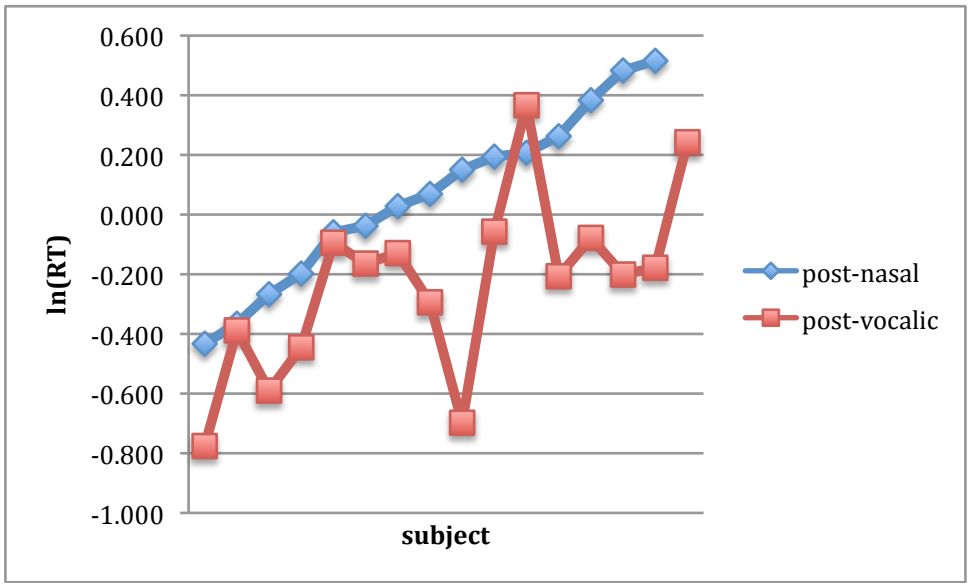
(400)



Note that most of the post-lateral RTs are lower than the post-nasal RTs, suggesting that the difference is easier to perceive in the post-lateral condition. A crucial exception is subject 16, who has a very high post-lateral RT. This will be discussed below. Subject 15 did not identify any of the post-nasal 'different' items accurately, so there are no RTs for him in that condition.

Comparing the post-nasal condition and the post-vocalic condition revealed a highly significant result, with $t(29) = -4.94$; $p < 0.001$; $\alpha = 0.017$, including a Bonferroni adjustment.

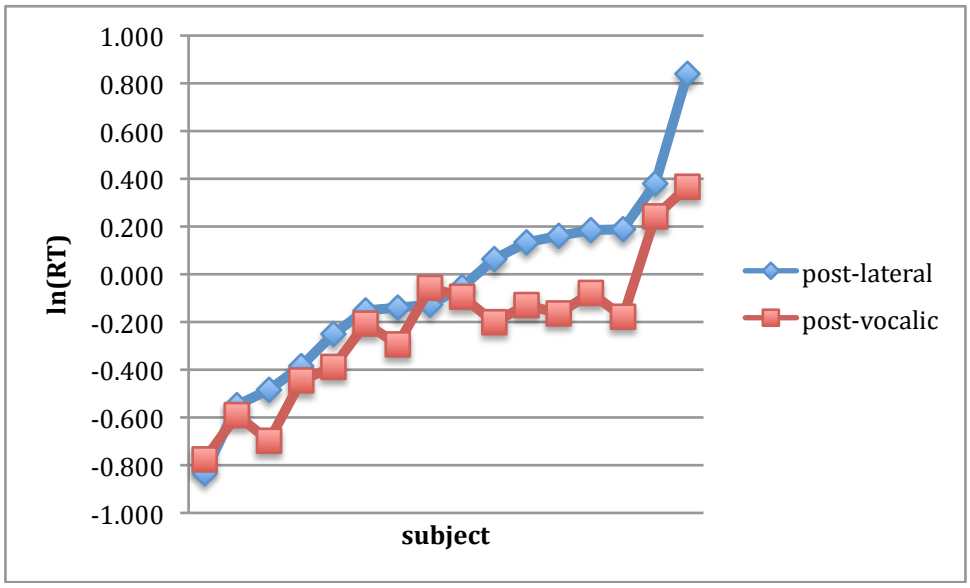
(401)



The post-vocalic RTs are generally lower than the post-nasal RTs; the detection of [n] is easier in the post-vocalic condition than in the post-nasal condition; a result independently established in the d′ analysis above.

Comparing the post-lateral condition with the post-vocalic condition resulted in $t(29) = 2.61$; $p = 0.014$, $\alpha = .017$, with a Bonferroni adjustment.

(402)



Note that the RTs in the post-vocalic condition are generally lower than those in the post-lateral condition, showing that the presence/absence of [n] is easier to discern in the post-vocalic position.

6.3.3 The post-nasal and post-lateral conditions revisited

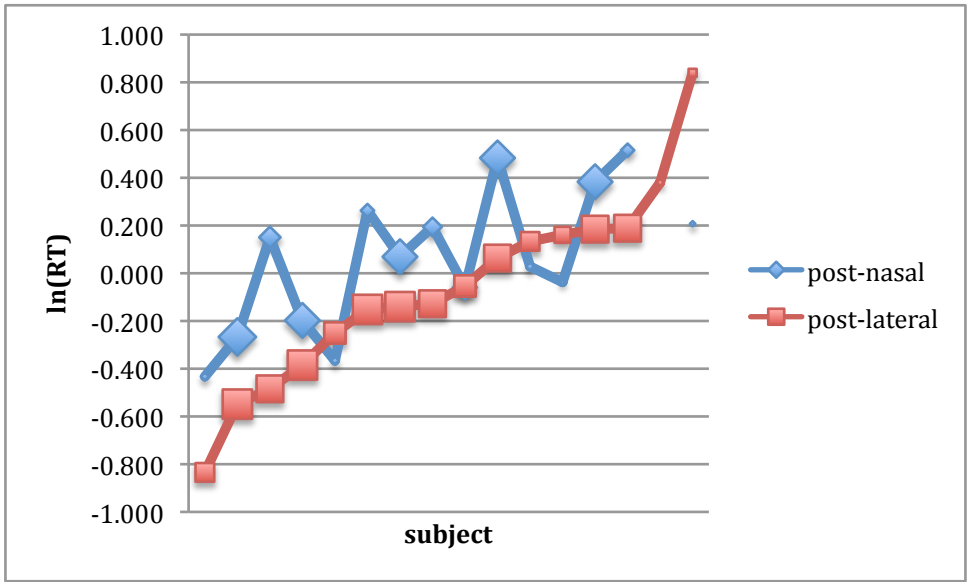
Recall that the contrast between the post-nasal RT and the post-lateral RT resulted in a statistically nonsignificant result, $p = 0.023$; $\alpha = .017$, with a Bonferroni adjustment. This is surprising, since the d′ analysis revealed a significant difference between these conditions. However, there is reason to doubt the accuracy of the value $p = 0.023$, since it is based on equal weighting among all subjects' mean ln(RT)s. That is, a subject whose mean is based on 3 correct responses carries equal weight as a subject whose mean is based on 29 correct responses (these are actual figures). Surely a mean based on 29 observations is more reliable than one based on 3 observations. To ensure maximal accuracy in the means of the ln(RT), a repeated measures ANOVA with

‘analytic weights’ was done, using Stata software; here, the ‘analytic weights’ were the number of correct responses in the ‘different’ condition.

The total means remained unchanged, of course: the mean ln(RT) in the post-nasal condition it was .062 (=1064 msec.); in the post-lateral condition -0.064 (=938 msec.); and in the post-vocalic condition -0.231 (=794 msec.). The omnibus test produced $F(2,29) = 25.50$; $p < 0.0001$.

Most importantly, the contrast between the post-nasal condition and the post-lateral condition was now highly significant, with $t(29) = -4.27$; $p < 0.001$, with $\alpha = 0.017$. The reason for this change is clear when we consider the graph. The boxes on the graph have been altered in size such that their area is proportional to the subject’s number of correct responses in the relevant condition; in other words, the box’s area corresponds to the value’s weight.

(403)



Notice that when the boxes of the post-nasal condition are very large, they are above the post-lateral condition. When the boxes of the post-nasal condition are below the post-

lateral condition, they are remarkably small. Subject number 16, for example, had only 3 correct answers out of 36 (18 being chance performance) in the post-nasal condition, and only 11 correct in the post-lateral condition (18 being chance performance); so his weights are accordingly small.

Applying an ANOVA with analytic weights maintains the significant results in the other conditions. The contrast between the post-nasal and post-vocalic conditions yield $t(29) = -7.11$; $p < 0.001$, with $\alpha = 0.017$, including a Bonferroni adjustment. Likewise, the contrast between the post-lateral condition and the post-vocalic condition yielded $t(29) = 3.36$; $p = 0.002$; with $\alpha = 0.017$, including a Bonferroni adjustment.

So, an ANOVA with analytic weights reveals that RTs in the task of identifying the difference between presence/absence of word-final [n] vary significantly depending on whether the sound preceding [n] is nasal, lateral, or vocalic.

6.3.4 A potential confound

A potential confound would result from variability in the duration of the nasal in the three conditions: assuming that the crucial information is the actual nasal consonant, a shorter nasal in the post-nasal condition could potentially explain the larger RTs in this condition. This is so, because the onset of the word-final nasal is the definitive evidence for 'difference' in the relevant condition.

To clarify, let us distinguish the Truthful Reaction Time (TRT, the duration from the onset of the nasal consonant until the mouse-click) and the Recorded Reaction Time (RRT, the duration from the end of the nasal consonant until the mouse-click). Consider the situation where there are two items with identical TRTs; assume furthermore that the duration of the nasals are different in the two items. This would result in two distinct RRTs. The shorter the nasal, the longer the RRT; the longer the

nasal, the shorter the RRT. In this way, the duration of the nasal can result in illusory differences in RRT.

Such a confound is not present in this study, however. First, the differences in nasal duration are minute compared to the differences in RTs in the three conditions. The average ln(duration) of the nasal consonant in the post-nasal, post-lateral, and post-vocalic conditions are -2.55, -2.76, and -2.77, respectively. These nasal durations correspond to values of 78 msec., 63 msec., and 62 msec., respectively. These might be compared to the average ln(RT) of the three conditions, which are +0.062, -0.064, and -0.231, respectively. These RTs correspond to durations of 1064 msec., 938 msec., and 794 msec., respectively.

Furthermore, notice that the duration of the nasals in the three conditions goes against the potential confound: the nasal is longest in the post-nasal condition (where the RTs are the longest) and shortest in the post-vocalic condition (where RTs are the shortest).

6.3.5 Local summary

Summing up the results, a d′ analysis showed that it was significantly harder to discern the presence/absence of [n] in the post-nasal condition than in the post-lateral condition or the post-vocalic condition. It failed to show any significant difference between the post-lateral and post-vocalic conditions. RT analysis without weights established that discernment of [n] in the post-nasal condition was more difficult than in post-vocalic condition; and discernment in the post-lateral condition was also more difficult than the post-vocalic condition. No significant difference was established between the post-nasal condition and the post-lateral condition. RT analysis with analytic weights established that the discernment of [n] in the post-nasal condition was

more difficult than in the post-lateral condition and in the post-vocalic condition; furthermore, the post-lateral condition was more difficult than the post-vocalic condition.

The following chart summarizes the findings of the preceding sections:

(404)

	Post-nasal vs. post-lateral	Post-lateral vs. post-vocalic
ANOVA of d′	$t(30) = 5.63$ $p < 0.001$ ($< \alpha$)	$t(30) = 0.75$ $p = 0.461$
Unweighted ANOVA of RT	$t(29) = -2.39$ $p = 0.023$	$t(29) = 2.61$; $p = 0.014$ ($< \alpha$)
Weighted ANOVA of RT	$t(29) = -4.27$ $p < 0.001$ ($< \alpha$)	$t(29) = 3.36$ $p = 0.002$ ($< \alpha$)

Statistically significant results are in boldfaced boxes.

6.4 Distinguishing [an] and [ɔn] from [ən]: Method

6.4.1 Introduction

Recall that the definite article /ən/ fails to surface after unstressed [ən] and [an], but surfaces overtly after unstressed [ɔn]. For example, the definite form of /ˈmʏrtən + ən/ ‘the myrtle’ and /ˈjɪslan + ən/ ‘the hostage’ are [ˈmʏrtən] and [ˈjɪslan], respectively; whereas the definite form of /ˈmɔrgɔn + ən/ is [ˈmɔrgɔnən], with an overt suffix. The explanation was that the words for ‘the myrtle’ and ‘the hostage’ feature segment combinations that trigger repetition blindness: for ‘the myrtle’, [ən] is trivially similar to itself; for ‘the hostage’, [ən] is sufficiently similar to [an] to trigger repetition blindness. ‘The morning’, on the other hand, features the sequence [ɔn] followed by

[ən], and these are not sufficiently close to trigger repetition blindness. So the assumption is that the difference between unstressed [ɔn]/[ən] is greater than the difference between unstressed [an]/[ən].

To establish this claim, an AX discrimination task was constructed, featuring nonsense words including the relevant unstressed syllables. Participants indicated by a mouse click whether the pair of tokens just heard represented the same word or different words.

6.4.2 Stimulus preparation

To avoid a confound of coarticulation in the unstressed vowel, where it might be colored by the preceding vowel, all stimuli were prepared by splicing. First, I will discuss the original recordings which were used as raw material for splicing; then I will consider the words that resulted from the splicing.

The stimuli were recorded by three native speakers of Swedish in the Los Angeles area. The identified themselves as native speakers, and they spoke the language fluently.

Three speakers were recorded saying the words /ˈtV$_1$tːV$_1$n/ and /ˈkV$_1$kːV$_1$n/, where the vowels varied between [a ə/ɛ[86] ɔ]. The speakers worked from orthographic cues. So the following words were recorded: [ˈtɛ̝tːən], [ˈtatːan], [ˈtɔtːɔn], [ˈkɛ̝kːən], [ˈkakːan], and [ˈkɔkːɔn]. They were instructed by example to pronounce them with Accent 1 (one of the Swedish pitch accents), to ensure uniformity among speakers. This pitch accent was illustrated by example. This pitch accent replication was non-problematic. Two tokens of each type were recorded by each speaker.

[86] Recall that short /e/ is realized as [ɛ̝] when under primary or secondary stress, and as [ə] when unstressed.

The recording was done in a soundproof booth using a Shure SM10a headworn microphone and PCQuirer software on a Dell Optiplex 170L computer. The tokens were uttered in the carrier sentence 'It was ____ I said' (Swedish: De' va' ___ ja' sa'). This carrier sentence ensures main stress on the token of interest, and uniform prosodic structure.

After recording was done, the words were edited out of their carrier sentence, and the average intensity of each speaker's utterances was set at 70 dB.

The stimuli were constructed from these words, by means of splicing. The stimuli were of the form /ˈtVtːVn/ and /ˈkVkːVn/, where the vowels varied between [ɛ̞/ə], [a], and [ɔ]. A stimulus like [ˈtatːən] was produced by the splicing together of the first half of [ˈtatːan] (i.e., [ˈtatː]) and the second half of [ˈtɛ̞tːən] (i.e., [ən]). Stimuli of the form $CV_1C{:}V_1n$—where the two vowels are identical—were spliced together from two distinct tokens of the same type. That is, a stimulus like [ˈtatːan] was produced by splicing the first half of one token of [ˈtatːan] (i.e., [ˈtatː]) with the second half of a different token of [ˈtatːan] (i.e., [an]). Thus, all stimuli were spliced.

The combination /ˈkɔkːVn/ was not used, since /ˈkɔkːən/ 'the cook' is a real Swedish word, which would skew the perception of the vowels.

The stimuli were paired up, to construct an AX same/different discrimination task. To make sure that the task was not trivial, the voice of the first token in a pair was always different from the voice of the second token in the pair.

The made-up words of the form /ˈtVtːVn/ and /ˈkVkːVn/ were paired in the following way: In the 'same' condition, /ˈCVCːən/ was paired with itself; /ˈCVCːan/ was paired with itself; and /ˈCVCːɔn/ was paired with itself. In the 'different' condition, /ˈCVCːən/ was paired with /ˈCVCːan/ twice (with order randomized each time); and

/ˈCVCːən/ was paired with /ˈCVCːɔn/ twice (with order randomized each time). So, the ratio same/different was 3:4. The resulting stimuli pairs were as follows:

(405)	[ˈtatːən]	[ˈtatːən]	
	[ˈtatːan]	[ˈtatːan]	
	[ˈtatːɔn]	[ˈtatːɔn]	
	[ˈtatːən]	[ˈtatːan]	x2 (randomized order)
	[ˈtatːən]	[ˈtatːɔn]	x2 (randomized order)
	[ˈtɛ̞tːən]	[ˈtɛ̞tːən]	
	[ˈtɛ̞tːan]	[ˈtɛ̞tːan]	
	[ˈtɛ̞tːɔn]	[ˈtɛ̞tːɔn]	
	[ˈtɛ̞tːən]	[ˈtɛ̞tːan]	x2 (randomized order)
	[ˈtɛ̞tːən]	[ˈtɛ̞tːɔn]	x2 (randomized order)
	[ˈtɔtːən]	[ˈtɔtːən]	
	[ˈtɔtːan]	[ˈtɔtːan]	
	[ˈtɔtːɔn]	[ˈtɔtːɔn]	
	[ˈtɔtːən]	[ˈtɔtːan]	x2 (randomized order)
	[ˈtɔtːən]	[ˈtɔtːɔn]	x2 (randomized order)
	[ˈkɛ̞kːən]	[ˈkɛ̞kːən]	
	[ˈkɛ̞kːan]	[ˈkɛ̞kːan]	
	[ˈkɛ̞kːɔn]	[ˈkɛ̞kːɔn]	
	[ˈkɛ̞kːən]	[ˈkɛ̞kːan]	x2 (randomized order)
	[ˈkɛ̞kːən]	[ˈkɛ̞kːɔn]	x2 (randomized order)

[ˈkakːən]	[ˈkakːən]	
[ˈkakːan]	[ˈkakːan]	
[ˈkakːɔn]	[ˈkakːɔn]	
[ˈkakːən]	[ˈkakːan]	x2 (randomized order)
[ˈkakːən]	[ˈkakːɔn]	x2 (randomized order)

Five trivially 'same' items were added; five trivially 'different' items were added. The trivially 'same' items were in fact the same sound-file. The trivially 'different' items were totally unrelated tokens, with different consonants or different stressed vowels. These were added to use as a criterion to reject subjects who were not paying attention. It was decided that a minimum of 90% accuracy among these items would be necessary to be included in the analysis. No subject was in fact rejected.

6.4.3 Testing procedure

The equipment and structure of the listening task was the same as in the experiment testing perceptibility of nasals.

6.4.4 Practice trials

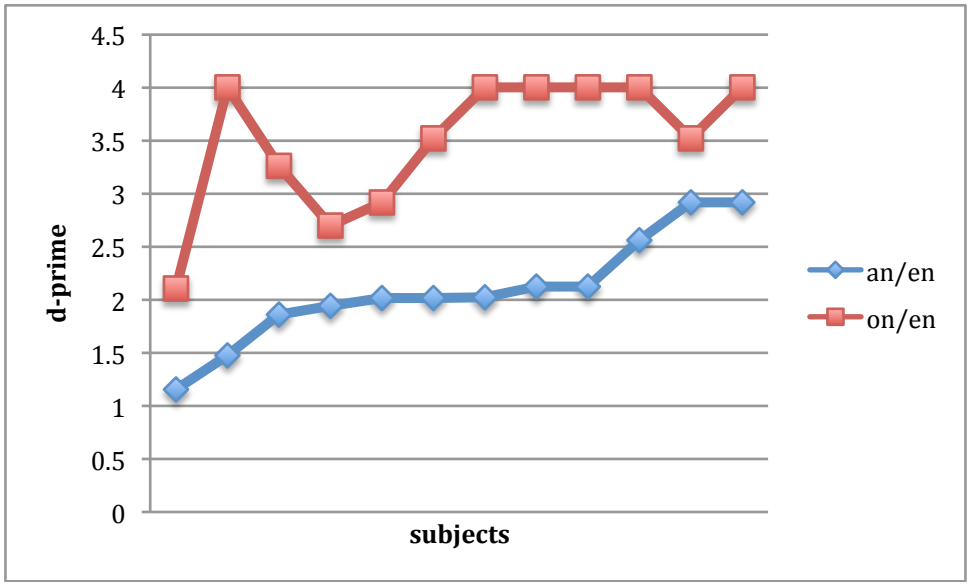
Five practice trials were given—three in the 'same' condition (one for each vowel), and two in the 'different' condition (featuring the contrast [ən]/[an] and [ən]/[ɔn]). Answers for the practice trials were given on the computer screen.

6.5 Distinguishing [an] and [ɔn] from [ən]: Results and discussion

6.5.1 d′ analysis

To determine whether the difference [ɔn]/[ən] was significantly greater than the difference [an]/[ən], the d′ values of 12 subjects were analysed. The mean d′ value for the [ɔn]/[ən] condition was 3.528, and the mean d′ value for the [an]/[ən] condition was 2.095. The ceiling d′ was 4.003. A paired samples t-test was performed on SPSS software, with the independent variables were condition (two levels: [an]/[ən] or [ɔn]/[ən]), and d′ was the dependent variable. The influence of condition was significant: $t(11) = 7.871$; $p < 0.001$.

(406)



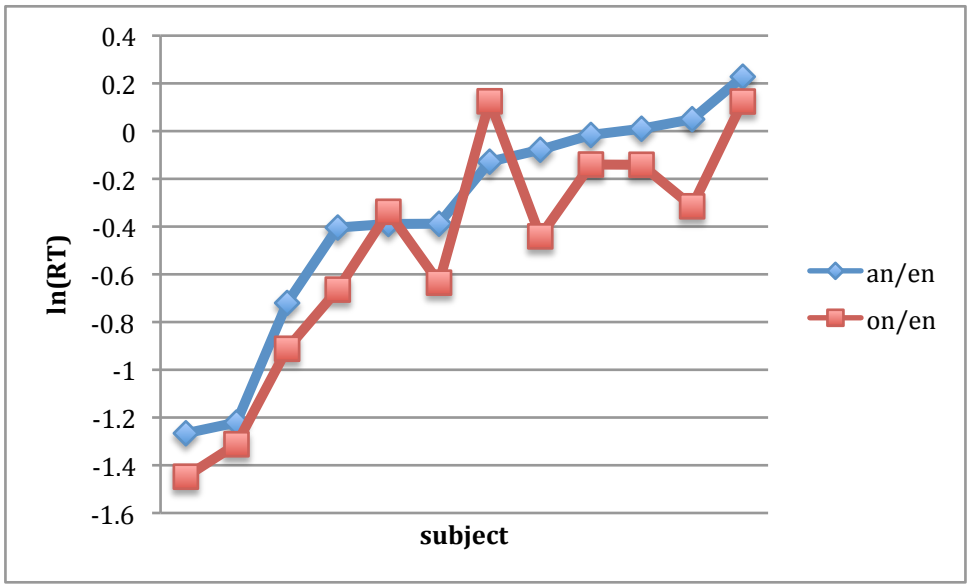
Notice that for each subject, the ability to notice the distinction [ɔn]/[ən] condition is consistently higher than the ability to notice the distinction [an]/[ən].

6.5.2 Reaction time analysis

If the distinction [an]/[ən] is more difficult to perceive than the distinction [ɔn]/[ən], we would expect there to be a greater RT associated with the correct

distinction [an]/[ən] than with the correct distinction [ɔn]/[ən]. To ascertain this, the ln(RT) values (on the correct responses on the different items) of 12 subjects were analysed. The mean ln(RT) for the [an]/[ən] condition was -0.360 (i.e., 698 msec.), and the mean ln(RT) for the [ɔn]/[ən] condition was -0.508 (i.e., 602 msec.). A paired samples t-test was performed on SPSS software, with condition as the independent variable (two levels: [an]/[ən] and [ɔn]/[ən]), and ln(RT) as the dependent variable. This showed that the difference is significant: $t(11) = 2.981$; $p = 0.012$. A graph of the result follows:

(407)



Note that the RTs for the condition [an]/[ən] are generally higher than those of condition [ɔn]/[ən]: the distinction is more difficult to perceive in the former than in the latter.

6.5.3 Local summary

The findings of both d′ analysis and RT analysis lend credence to the claim that Δ ([an],[ən]) < Δ ([ɔn],[ən]), which is necessary for an account that states that the

haplological definite form of words like [ˈvɛ̝ntan] ‘the wait’ is driven by a gradient form of repetition blindness, the phenomenon which uncontroversially explains the lack of overt suffixation on words like [ˈmʏrtən] ‘the myrtle’. This contrasts with the overt definite marking in words like [ˈmɔrɡɔnən] ‘the morning’.

6.6 Repetition blindness triggered by [ən], [an], [ɔn]: Method

6.6.1 Introduction

The previous experiment established that the perceptual distance between [ɔn] and [ən] is greater than that between [an] and [ən]. It was not established that actual repetition blindness results from this similarity.

An AX same/different discrimination task was designed to test whether the difference [ənən]/[ən] and [anən]/[an] is smaller than the difference [ɔnən]/[ɔn]. That result would establish whether repetition blindness renders the last syllable in [ənən] and [anən] hard to perceive. Participants indicated by a mouse click whether the pair of tokens just heard represented the same word or different words.

6.6.2 Stimulus preparation

The stimuli were recorded by three native speakers of Swedish in the Los Angeles area. They identified themselves as native speakers, and spoke fluently with the experimenter.

A list of nonsense words featuring unstressed [ən], [an], and [ɔn] were recorded, together with minimally different nonsense words ending in unstressed [ənən], [anən], and [ɔnən]. For example, six nonsense words that were recorded were [ˈtatːən], [ˈtatːənən], [ˈtatːan], [ˈtatːanən], [ˈtatːɔn], and [ˈtatːɔnən].[87]

[87] A complete list of stimuli is included in appendix 14.

To avoid complications of varied manifestations of pitch accent, the speakers were instructed to utter these words with Accent 1. This pitch accent was illustrated by example, and the speakers could replicate the pitch accent without difficulty.

The three speakers were recorded saying two tokens of each nonsense word, using written cues. The nonsense words were uttered in the carrier sentence 'It was _____ I said' (Swedish: De' va' _____ ja' sa'). This ensured a uniform prosodic contour for each item. The speakers were recorded in a soundproof booth using PCQuirer software on a Dell Optiplex 170L computer and a Shure SM10a headworn microphone.

After recording was done, the items were edited out of the carrier sentence, and the average intensity of each speaker's utterances was set at 70 dB.

At a normal speech rate the distinction same/different would be trivial, since the subject need only attend to the total duration of the word to tell if there is a final unstressed [ən]. To circumvent this problem, the duration of each item was manipulated: the two items in a given pair were made to have the identical duration; this duration was the mean of the original durations of the two items. This was done by means of a script, using the PRAAT command Convert: Lengthen.

6.6.3 Testing procedure

Subjects in the experiment were 16 native speakers of Swedish in the Los Angeles area.

The ratio of same/different pairs was 1:1. Among the same stimuli, half lacked a final unstressed [ən], and half had a final unstressed [ən]. Among the 'different' stimuli, the order of the stimuli were randomized, so that half of the time the first item

featured the final [ən], and the second item lacked the final [ən]; half of the time the order was the opposite.

To increase the difficulty of the task, different voices in the test items were paired with each other. With three voices recorded, there were three different pairs of voices. With the order of the items randomized, this provided six different voice/order combinations.

Five trivially 'same' items were added; five trivially 'different' items were added. The trivially 'same' items were in fact the identical sound-file. The trivially 'different' items were totally unrelated tokens, with different consonants or different stressed vowels. These were added as a criterion to reject subjects who were not paying attention. It was decided that a minimum of 90% accuracy among these items would be necessary to be included in the analysis. No subject was in fact rejected.

The procedure and equipment of the listening task was the same as in the experiment testing perceptibility of nasals.

The stimuli (excluding samples with answers) were repeated 3 times, in randomized blocks, and the computer kept track of both their answers and their RTs (as calculated from the end of the second stimulus).

6.6.4 Practice trials

Nine practice trials were given—six in the 'same' condition (one each for [ən], [ənən], [an], [anən], [ɔn], and [ɔnən]), and three in the 'different' condition (featuring the contrast [ən]~[ənən], [an]~[anən] and [ɔn]~[ɔnən]. Answers for the practice trials were given on the screen. The tokens used in the practice trials were not used in the actual test.

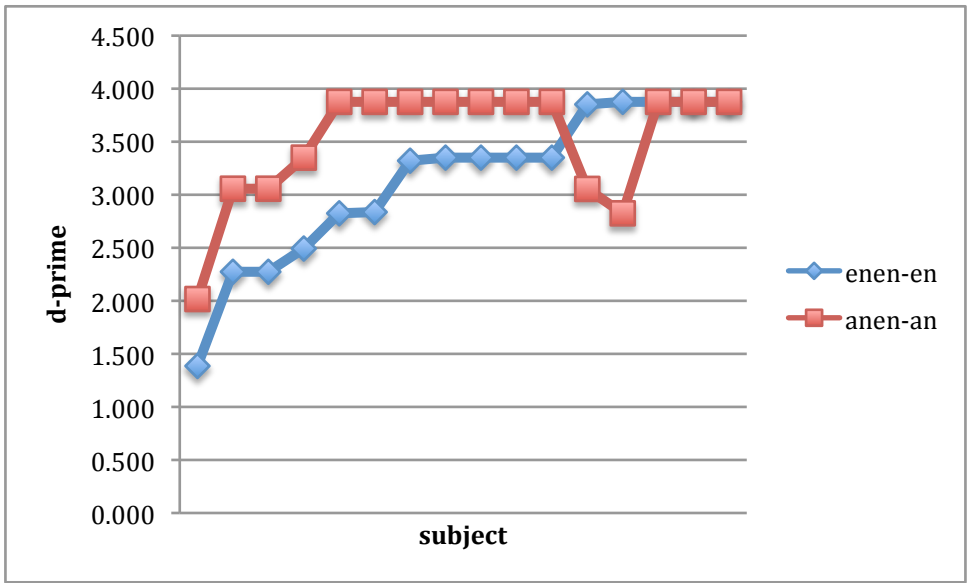
6.7 Repetition blindness triggered by [ən], [an], [ɔn]: Results and discussion

6.7.1 d′ analysis

A d′ analysis was performed on the pairs [ənən]/[ən], [anən]/[an] and [ɔnən]/[ɔn].

The contrast [ən]/[ənən] yielded the lowest mean d′ value, of 3.135. The contrast [an] ~ [anən] yielded a higher mean d′ value of 3.508. Finally, the contrast [ɔn] ~ [ɔnən] yielded the highest d′ value of 3.541. The ceiling d′ was 3.876.

A repeated measures ANOVA was applied to the d′ data, using Stata software. The omnibus test yielded $F(2,30) = 5.75$, highly significant with $p = 0.008$. The comparison between constrasts [ən]/[ənən] and [an]/[anən] was found to be significant, with $t(30) = 2.80$, and $p = 0.009$, with $\alpha = 0.017$, including a Bonferroni adjustment. (408)

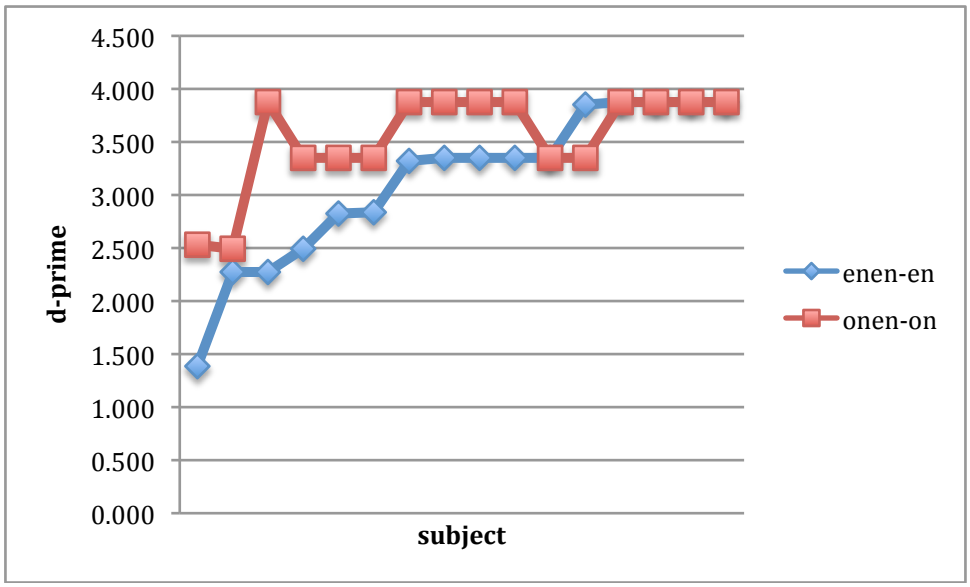


Note that the line with the diamond shapes—representing the [ən]/[ənən] contrast—is generally at a lower level than the line with the square shapes—representing the

[an]/[anən] contrast. In fact, many subjects identified [an]/[anən] at ceiling level. The constrast [ən]/[ənən] is more difficult to detect than the contrast [an]/[anən].

Unsurprisingly, the contrast [ən] ~ [ənən] is also more difficult to detect than the contrast [ɔn] ~ [ɔnən]. A repeated measures ANOVA yielded a significant result: $t(30) = 3.06$; $p = 0.005$, with $\alpha = 0.017$, with a Bonferroni adjustment.

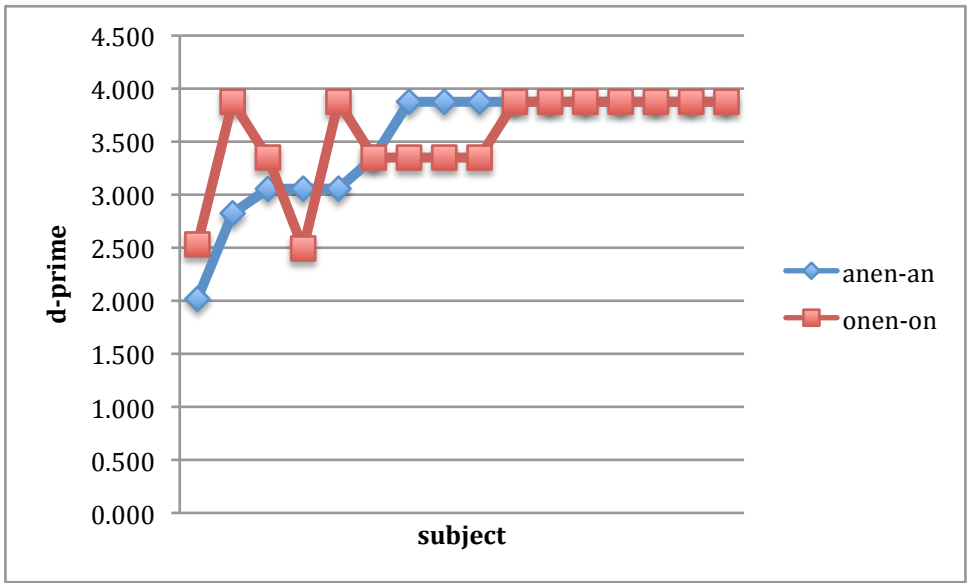
(409)



Notice that the line with square shapes—the contrast [ɔn]/[ɔnən]—is generally above the line with diamond shapes— the contrast [ən]/[ənən].

The comparison between the contrasts [an] ~ [anən] and [ɔn] ~ [ɔnən], however, did not yield any significant difference. With $t(30) = -.25$, the p value was nonsignificant, $p = 0.802$, $\alpha = 0.017$, with a Bonferroni adjustment. The following graph illustrates the pattern:

(410)



The line with diamond shapes is the contrast [an] ~ [anən]; the line with square shapes is the contrast [ɔn] ~ [ɔnən]. Notice that the lines overlap throughout most of the distribution; for almost half of the subjects, performance was at ceiling level (d′ = 3.876) for both conditions.

The task was clearly too easy for the subjects, so it failed to establish a difference between the contrasts [an]/[anən] and [ɔn]/[ɔnən]. Some distraction or challenge should be introduced to render the task less trivial.

6.7.2 Reaction time analysis

An analysis of RTs was undertaken, to see if they reveal any differences between the three conditions. No significant results were found in this analysis.

The following chart illustrates the mean ln(RT)s in each condition, also translated as raw msec.

(411)	[ən]/[ənən]	-0.644	(=525 msec.)
	[an]/[anən]	-0.570	(=566 msec.)
	[ɔn]/[ɔnən]	-0.624	(=536 msec.)

Notice that the relative RTs of the difference [ən]/[ənən] are the opposite of what was expected: it was expected that this would have the highest mean RT of the three conditions, but in fact it had the lowest mean RT.

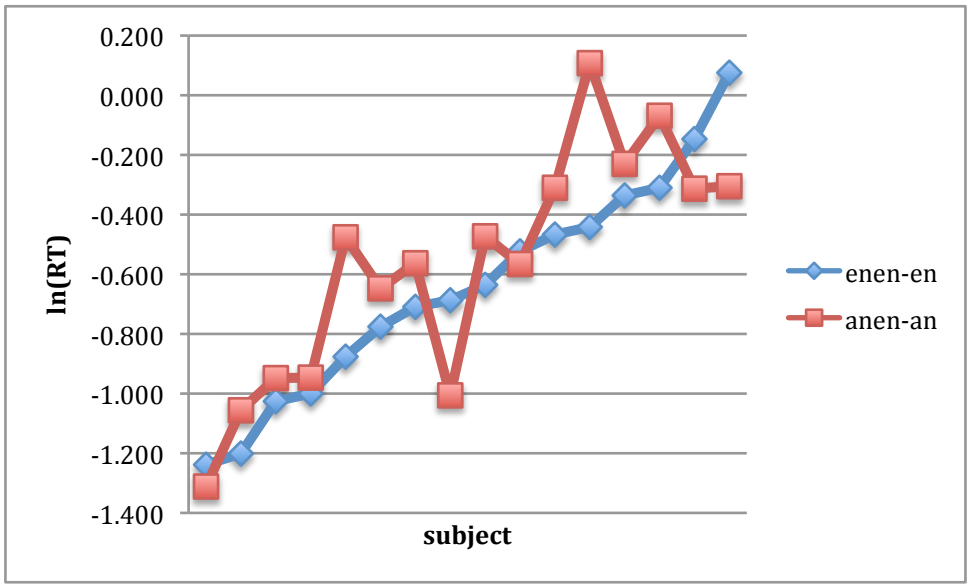
An omnibus test was run, and no significant influence of condition was found. The independent variable was condition (three levels: [ən]/[ənən]; [an]/[anən]; [ɔn]/[ɔnən]). The dependent variable was ln(RT). This resulted in $F(2,30) = 0.85$ and $p = 0.4369$. With $\alpha = 0.05$, this is not significant.

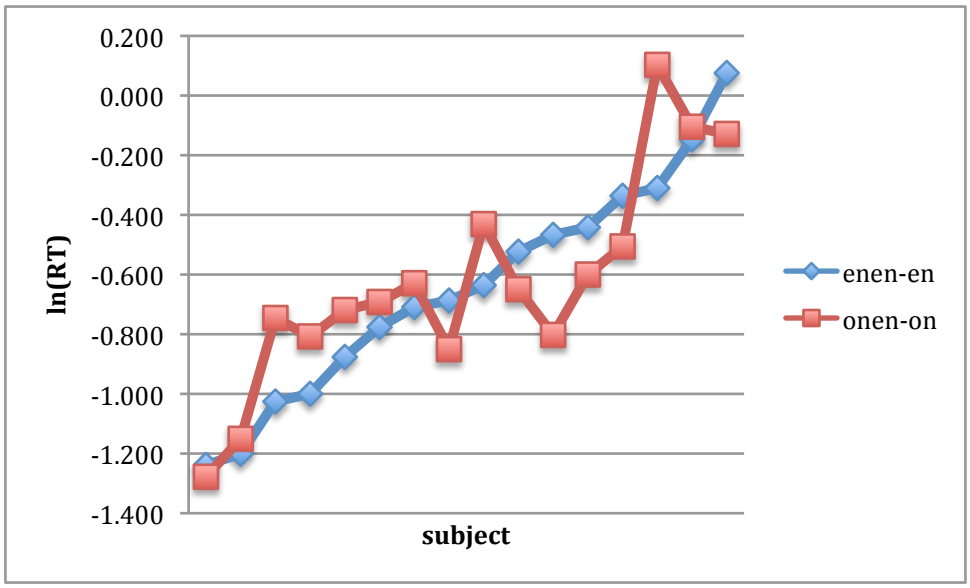
The t-values and p-values of the three relevant comparisons were made; in no case were they significant. These are summarized in the following chart:

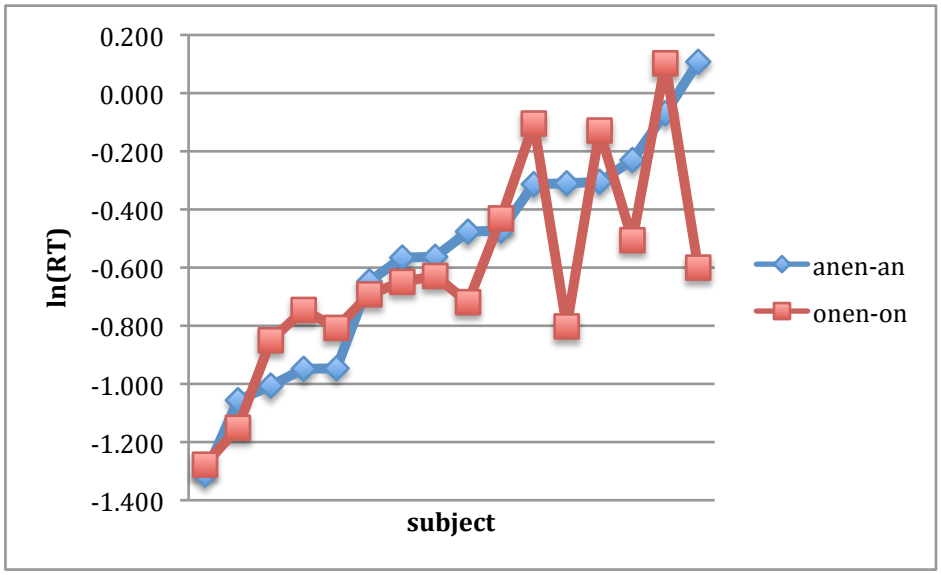
(412)	t(30)	p	α
[ən]/[ənən]~ [an]/[anən]	1.26	0.219	0.017
[ən]/[ənən]~ [ɔn]/[ɔnən]	0.32	0.748	0.017
[an]/[anən]~ [ɔn]/[ɔnən]	0.93	0.359	0.017

The actual results are captured in the following three graphs:

(413)


0.200
0.000
-0.200
-0.400
-0.600
-0.800
-1.000
-1.200
-1.400
ln(RT)
subject
enen-en
anen-an


0.200
0.000
-0.200
-0.400
-0.600
-0.800
-1.000
-1.200
-1.400
ln(RT)
subject
enen-en
onen-on



No obvious trends or insights can be found in these graphs.

As mentioned above in the d′ analysis, the task is presumably too easy as designed, and some distraction or challenge needs to be introduced to render the perception more difficult.

6.7.3 Local summary

d′ analysis showed that the difference [ən]/[ənən] is more difficult to detect than the differences [an]/[anən] and [ɔn]/[ɔnən]. Neither d′ analysis nor RT analysis established that the pair [an]/[anən] was harder to distinguish than the pair [ɔn]/[ɔnən].

6.8 Perceptibility of degemination: Method

6.8.1 Introduction

Recall from Chapter 3 that the supine, preterite, and participial suffixes feature geminate dental stops, which are degeminated in post-consonantal position. It was assumed that the contrast geminate/singleton would be less salient after a consonant

than after a stressed vowel, since a consonant would provide less clear transitional cues than a stressed vowel. So, the degemination of the long suffixal consonant is licensed post-consonantally, but not post-vocalically.

To test whether the perceptibility of the contrast geminate/singleton in the sounds [d] and [t] differed depending on whether the preceding sound was a vowel or a consonant, an AX discrimination task was prepared, featuring the two conditions. The consonant condition included the consonants [g] and [k] (depending on whether the following consonant was [d] or [t]); [n]; [l]; and the glide [j] (which triggers degemination like other consonants). So pairs to be tested included nonsense words of the following types:

(414)	short/long [d]	short/long [t]
	[tVda]/[tVdːa]	[tVta]/[tVtːa]
	[tVgda]/[tVgdːa]	[tVkta]/[tVktːa]
	[tVnda]/[tVndːa]	[tVnta]/[tVntːa]
	[tVlda]/[tVldːa]	[tVlta]/[tVltːa]
	[tVjda]/[tVjdːa]	[tVjta]/[tVjtːa]

Participants indicated by a mouse click whether the pair of tokens just heard represented the same word or different words.

6.8.2 Stimulus preparation

The stimuli were recorded by two native speakers of Swedish in the Los Angeles area. The identified themselves as native speakers, and spoke fluently.

Nonsense items of the following structure were recorded: /ˈtVtːa/, /ˈtVːta/, /ˈtVdːa/, /ˈtVːda/, where V was varied among [iː eː øː oː] for the long tokens, and among [ɪ ɛ̝ ø̞ ɔ] for the short tokens. Two speakers were recorded (working from orthographic

cues) on a Dell Optiplex 170L computer in a soundproof booth using PCQuirer software and a Shure 10A headworn microphone. The carrier sentence 'It was ____ I said' was used (Swedish: De' va' ____ ja' sa').

The glide [j] following the token in the carrier sentence resulted in coloration of the latter part of the token's final vowel. After the tokens were edited out of the carrier sentence, this [j]-colored portion was removed, and the uncolored part was lengthened using 'duration points' in PRAAT. These were checked for naturalness.

The stimuli were manipulated such that they had the same long:short duration ratio. This was done in the following way: The average duration of the long [tː] and [dː] for one speaker was calculated; and the average duration of the short [t] and [d] for both speakers was calculated. For the speaker whose both long and short averages were calculated, the ratio long:short was calculated. From this ratio, the duration of a hypothetical 'long' consonant for the other speaker was calculated, such that the long:short duration ratio of the consonants of the two speakers was identical. These calculations provided the duration of 'long' and 'short' of each speaker, which were used in the experiment. All of the 'long' /t/ sounds were to have the identical duration for a given speaker; all the long /d/ sounds were to have the identical duration for a given speaker; the same is true for short /t/ and /d/.

The stimuli for the post-vocalic condition for the experiment were constructed in the following way: the recordings of the form /ˈtVtːa/ and /ˈtVdːa/ had the duration of the (word-medial) [t] and [d] altered, to conform to the 'long' and 'short' durations, discussed above. So, the medial [t] in /ˈtVtːa/ was constructed to have the 'long' duration discussed above; the form /ˈtVta/—with a short [t]—was constructed from the same stimulus, by editing the closure portion of the [t] to have the 'short' duration discussed above.

In the case of [d], the stimuli were prepared by editing the entire [dːa] and [da] portions from one particular token of /ˈtVdːa/ and /ˈtVːda/, respectively. In particular, it was edited from the token whose [d] duration was closest to the 'long' and 'short' durations of each speaker, as discussed above. These edited [dːa] and [da] portions were appended to the /ˈtV/ part of the /ˈtVdːa/ stimuli. So, the final results were spliced /ˈtV + dːa/ and /ˈtV + da/, where ' + ' marks the location of the splice. All tokens ending in [dːa] had, then, the identical second syllable; the same is true for all tokens ending in [da].

The stimuli for the post-consonantal condition were prepared similarly. The same two speakers were recorded saying words of the structure /C_1VC_2ta/ and /C_1VC_2da/, where C_2 varied among [k n l j] for the former structure and [g n l j] for the latter. The durations of the [t] were manipulated to be 'long' and 'short' in the manner described above, by editing stop closure. The durations in the suffix-initial stop in the post-consonantal condition were identical to the durations in the post-vocalic condition. The /da/ portion of the /C_1VC_2da/ words was removed, and replaced with the 'long' [dːa] and 'short' [da] fragments, just like the post-vocalic stimuli discussed above. That is, the final results were spliced /C_1VC_2 + da/ and /C_1VC_2 + dːa/, where ' + ' marks the location of the splice.[88]

6.8.3 Testing procedure

Subjects were 20 native speakers of English in the Los Angeles area, of which 2 were rejected for not concentrating (criteria for rejection are discussed below), leaving 18 subjects whose data were analyzed. The identified themselves as native speakers in a pre-experiment questionnaire; they also identified themselves as having normal

[88] A complete list of stimuli is included as appendix 15.

hearing and normal control over their hands and fingers (to manipulate a computer mouse). While other experiments featured speakers of Swedish, it was thought prudent to use speakers of English in this exercise, since the task involved identifying long and short consonants in varying environments, and Swedish speakers would be biased by their knowledge of their own language's phonotactics (which allows only long consonants after stressed short vowels). Since English does not feature distinctive consonant length, such a confound would not arise with speakers of English.

The test was run using MATLAB software, on a Dell Latitude D810 laptop computer with Sony MDR-V200 headphones, and a Logitech corded USB optical mouse with two buttons (left and right). The volume was set at maximum for all subjects. The program randomized the order of the elements of each pair. The order among the pairs was also randomized. The ratio same/different among the pairs was 1:1. Among the same stimuli, half had two 'short' [d] or [t] sounds; and half had two 'long' [d] or [t] sounds. Among the 'different' stimuli, the order of the stimuli were randomized, so that half of the time the first item featured a 'long' [dː] or [tː]; and half of the time the first item featured a 'short' [d] or [t].

To make the task sufficiently challenging, the first and second item in each pair always featured different voices in the test items.

Five trivially 'same' items were added; five trivially 'different' items were added. The trivially 'same' items were in fact the same sound-file. The trivially 'different' items were totally unrelated tokens, with different consonants or different stressed vowels. These were added to use as a criterion to reject subjects who were not paying attention. It was decided that a minimum of 90% accuracy among these items would be necessary to be included in the analysis. As mentioned, two subjects were in fact rejected on these grounds.

The paradigm used was that of an Artificial Language experiment (Saffran, Newport & Aslin 1996). However, like in most such experiments, there was no attempt to teach participants new words, paradigms, or regularities. Instead, participants were tested on stimuli containing an unfamiliar contrast after only minimal practice exposure. Subjects were informed (both orally and in written form on the screen) that they would 'hear words from a made-up language called Boolu.' Furthermore, '[i]n this language, people care about how long a sound is. So, different sound durations give different words.'

Subjects were given instructions to press a button on a mouse marked 'SAME WORD' if they heard two voices say the same word; and to press a button marked 'DIFFERENT WORDS' if they heard two voices say different words. Subjects were asked to work as quickly and accurately as possible. Instructions were written on the computer screen, and were also read aloud. Subjects were instructed to hold the mouse with both hands, and use their thumbs to click on the buttons. To circumvent a bias of right/left-handedness resulting in skewed RTs, the association with the left button or right button with SAME WORD alternated for every other subject, so 50% of the time it was associated with the left button, and 50% of the time with the right button. The English phrases SAME WORD and DIFFERENT WORDS were taped to the mouse buttons, and the phrases also appeared on the screen on the right or left side, respectively, matching the ordering on the mouse buttons.

The stimuli (excluding samples with answers) were repeated 3 times, in randomized blocks, and the computer kept track of their answers.

6.8.4 Practice trials

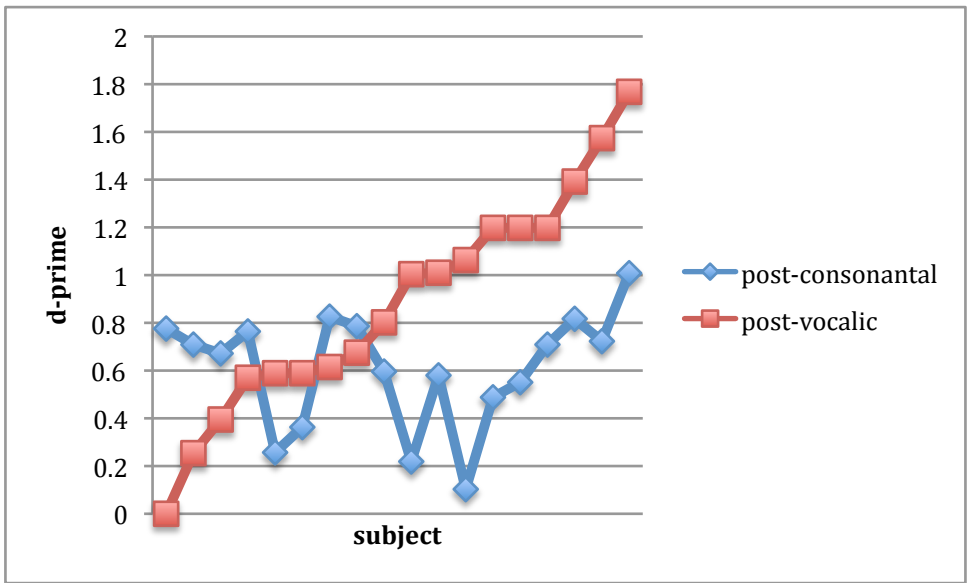
Subjects were coached on nine practice trials, where they were informed by a text on the screen before each word-pair not only if they were ‘same’ or ‘different’, but also by virtue of what they were ‘same’ or ‘different’ (e.g., ‘the “t” sound in the first word is short, but the “t” sound in the second word is long.’). The practice trials featured length distinctions in the sounds [t] and [d], just like the real trials.

6.9 Perceptibility of degemination: Results and discussion

6.9.1 d′ analysis

A pairwise t-test was performed on d′ values using SPSS software, comparing the detection of geminate [tː] and geminate [dː] in post-consonantal position as compared to post-vocalic condition. The dependent variable was context (2 levels: post-consonantal and post-vocalic) and the independent variable was d′ value (the sensitivity index). The mean d′ value for the post-consonantal condition was 0.608 (where ceiling would be 4.63); the mean d′ value for the post-vocalic condition was 0.883 (where ceiling would be 3.501). This resulted in $t(17) = -2.307$; $p = 0.034$.

(415)

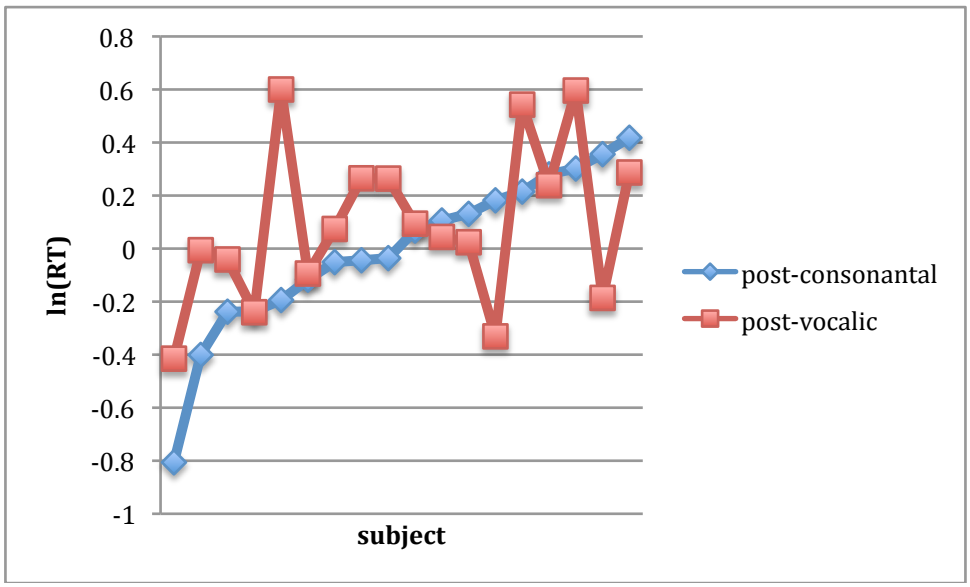


Notice that the d′ value for the post-consonantal condition is generally lower than that of the post-vocalic condition: The distinction singleton/geminate is harder to detect after a consonant than after a vowel.

6.9.2 Reaction time analysis

A pairwise t-test was performed on ln(RT) values using SPSS software, to see if the results of the d′ analysis would be replicated. Surprisingly, this was not the case. The independent variable was context (2 levels: post-consonantal and post-vocalic) and the dependent variable was ln(RT). The mean ln(RT) for the post-consonantal condition was -0.004 (i.e., 996 msec.); the mean ln(RT) for the post-vocalic condition was 0.095 (i.e., 1100 msec.). The mean RT of the post-consonantal condition is shorter than that of the post-vocalic condition. The effect is however not significant, with $t(17) = -1.296$; $p = 0.212$. The following chart illustrates the distribution of values:

(416)



There is no clear tendency to be discerned in this distribution.

6.9.3 Local summary

Results from d′ analysis suggest that degemination is less salient after consonants than after vowels. This provides an explanation for why the Swedish grammar permits the unfaithful mapping C: → C after consonants, but not after vowels. The saliently unfaithful output is dispreferred by the grammar. Results from RT analysis were uninformative.

6.10 Distances between vocalic tense/lax pairs: Method

6.10.1 Introduction

Recall from Chapter 4 that vowel pairs [ɑ a] and [ʉ ɵ] resist alternation in verbal and adjectival paradigms, and that the vowels [a] and [ɵ] exceptionally block post-alveolar coalescence of the sequence [rd], such that the lax vowels resist

correspondence with their tense counterparts. It was claimed that the vowel pairs [ɑ a] and [ʉ ɵ] feature a greater perceptual distance than other tense/lax vowel pairs of Swedish.

To test whether this is the case, an AX discrimination task was prepared, featuring all tense/lax vowel pairs. Participants indicated by a mouse click whether the pair of tokens just heard represented the same word or different words.

6.10.2 Stimulus preparation

One Swedish speaker was recorded for all stimuli in this experiment. She identified herself as a native speaker in a pre-recording interview, and spoke the language fluently with the experimenter. She was from Uppsala.

Words featuring the tense vowels in the frame [hVːt] were recorded; these included all the tense Swedish vowels [i, y, ʉ, e, ø, ɛ, ɑ, o, u]. So, the tense vowels were recorded in the following contexts: [hiːt], [hyːt], [hʉːt], [heːt], [høːt], [hɛːt], [hɑːt], [hoːt], [huːt].

Also, words featuring the lax vowels in the frame [hVtː] were recorded; these included all the lax Swedish vowels [ɪ, ʏ, ɵ, ɛ̞, ø̞, a, ɔ, ʊ]. So, the lax vowels were recorded in the following structures: [hɪtː], [hʏtː], [hɵtː], [hɛ̞tː], [hø̞tː], [hatː], [hɔtː], [hʊtː].

The words were recorded with no carrier sentence. (It had been found that the carrier sentence 'It was _____ I said' [Swedish: De' va' _____ ja' sa'] resulted in a palatalization of the final /t/ in the made-up words.) The words were presented to the speaker in Swedish orthography. Each item was recorded four times, to ensure quality of sound, and variation among stimuli. The speaker was instructed—by example—to maintain prosodic consistency, and avoid list intonation or dramatic prosodic shifts. This ensured a uniform prosodic contour for each item. The speaker followed these

instructions successfully. The speaker was recorded in a quiet room using PRAAT software and a Logitech USB laptop microphone. After recording was done, the average intensity of the speaker's utterances was set at 65 dB (the other experiments were run at 70 dB, but here there was a distortion of the vowel [ɑ] at 70 dB.)

Since vowels differ as to whether length is a significant cue in distinguishing the tense from the lax variant (Hadding-Koch and Abramson 1964; Thorén 2008), all the vowels and coda consonants were manipulated, such that all tense vowels had the same duration (which was the mean length of the recorded tense vowels); and all the lax vowels had the same length (which was the mean length of the recorded lax vowels). Also, the coda consonant was manipulated such that all coda consonants following tense vowels had the same duration (which was the mean length of the coda consonant after tense vowels); and all coda consonants following lax vowels had the same duration (which was the mean length of the coda consonant after tense vowels). Alterations in segment duration was done with PRAAT software, using 'duration points'. After manipulation, all the tense vowels had the same duration; all the lax vowels had the same duration; all the post-tense coda consonants had the same duration; and all the post-lax coda consonants had the same duration.[89]

6.10.3 Testing procedure

The test was run on 16 native speakers of Swedish in the Los Angeles area. They identified themselves as native speakers in a pre-experiment questionnaire, and also identified themselves as having normal hearing and normal ability to use their hands and fingers (to use a computer mouse).

---

[89] A complete list of stimuli is included as appendix 16.

The test was run using MATLAB software, on a Dell Latitude D810 laptop computer, with Sony MDR-V200 headphones and a Logitech corded USB optical mouse with two buttons (left and right). The program randomized the order of the elements of each pair. The order among the pairs was also randomized. The ratio same/different among the pairs was 1:1. Among the 'same' stimuli, half were tense-tense pairs, and half were lax-lax pairs. Among the 'different' stimuli, only vowels that pattern paradigmatically were matched. For example, the vowels [ɑ] and [a] correspond in nickname formation (cf. [jɑːn]~[janːɛ]), so these constituted a relevant tense/lax pair. The vowels [ɑ] was not matched with any lax vowel other than [a], since it does not pattern paradigmatically with any other lax vowel. The tense/lax matches were as follows:

(417)

orthography	tense	lax
a	[ɑ]	[a]
u	[ʉ]	[ɵ]
i	[i]	[ɪ]
y	[y]	[ʏ]
e	[e]	[ɛ̝]
ö	[ø]	[ø̞]
ä	[ɛ]	[ɛ̝]
å	[o]	[ɔ]
o	[u]	[ʊ]

There is a one-to-one correspondence between tense and lax vowels, except for lax [ɛ̝], which corresponds to both tense [e] and tense [ɛ]; this is a case of neutralization among the lax vowels.

Among the ‘different’ stimuli, the order of the stimuli were randomized, so that half of the time the first item featured a tense vowel, and the second item featured a lax vowel; half of the time the order was the opposite.

To ensure that the task was non-trivial, different tokens for the ‘same’ test items were paired.

Five trivially ‘same’ items were added; five trivially ‘different’ items were added. The trivially ‘same’ items were in fact the same sound-file. The trivially ‘different’ items were totally unrelated tokens, with paradigmatically unrelated tense/lax vowels. These were added to use as a criterion to discard subjects who were not paying attention. It was decided that a minimum of 90% accuracy among these items would be necessary to be included in the analysis. No subject was in fact discarded.

The recording of the results was the same as in the test on the perceptibility of nasals.

The stimuli (excluding samples with answers) were repeated 3 times, in randomized blocks, and the computer kept track of both their answers and their RTs (as calculated from the end of the second stimulus).

6.10.4 Practice trials

Four practice trials were given—two in the ‘same’ condition (one each for lax/lax ([ɪ]/[ɪ]) and tense/tense ([iː]/[iː]), and one each for tense/lax ([iː]/[ɪ]), and lax/tense ([ɪ]/[iː]). Answers for the practice trials were given on the screen. The sound-files used in the practice trials were not used in the actual test.

6.11 Distances between vocalic tense/lax pairs: Results and discussion

6.11.1 d′ analysis

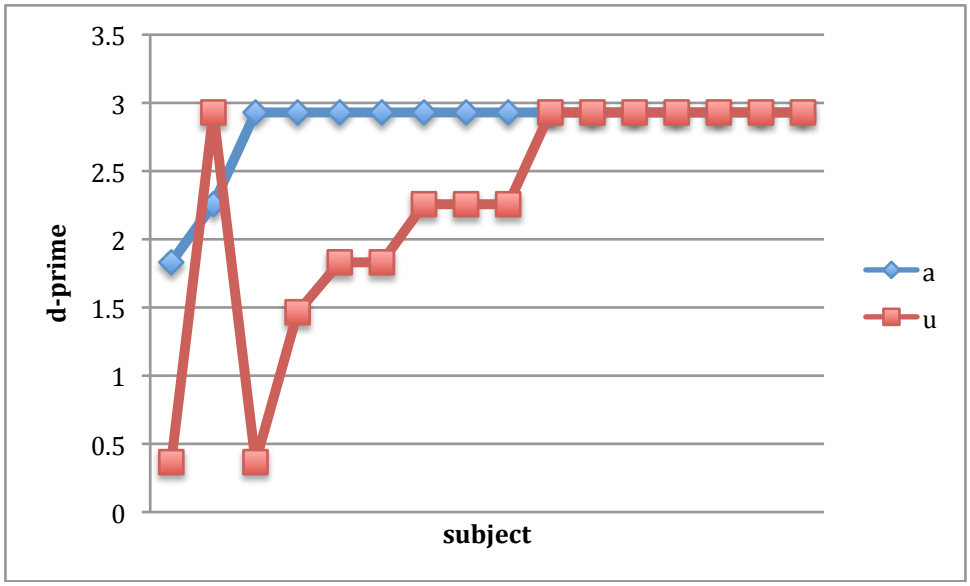
To establish perceptual distances between tense and lax correspondents, repeated measures ANOVA on both d′ values were applied, using Stata software. There was one independent variable, vowel pair; which had nine levels, one for each tense/lax pair. The dependent variable was d′ , the sensitivity index. The results were relatively uninformative, due to an error in experiment design, which will be discussed below.

For the d′ results, an omnibus test established a highly significant result, with $F(8, 120) = 3.64$ and $p = 0.0008$.

The only vowel pair which produced a significant difference in d′ compared to [ɑ]/[a] and [ʉ]/[ɵ] was the pair [u]/[ʊ]. Other pairs resulted in non-significant differences in d′. The mean d′ for the [ɑ]/[a] pair was 2.82; the mean d′ for the [ʉ]/[ɵ] pair was 2.75; and the mean d′ for the [u]/[ʊ] pair was 2.25. The ceiling d′ was 2.852.

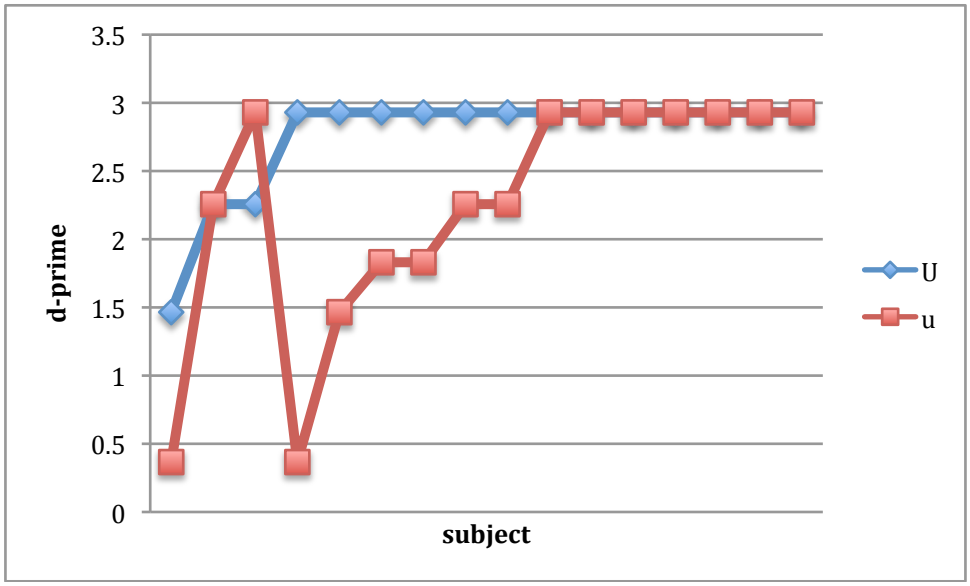
The contrast between the d′ of the [ɑ]/[a] pair and the [u]/[ʊ] pair was highly significant, with $t(120) = -3.65$; $p < 0.001$; $\alpha = 0.05/14 = 0.004$, with a Bonferroni adjustment.

(418)



The symbol 'a' represents the pair [ɑ]/[a], and the symbol 'u' represents the pair [u]/[ʊ]. The distinction [ɑ]/[a] was trivial for nearly all subjects, resulting in performance near ceiling level; whereas the distinction [u]/[ʊ] was trivial for only half of the subjects. The difference [ɑ]/[a] is easier to detect than the difference [u]/[ʊ].

(419)



The symbol 'U' represents the pair [ʉ]/[ɵ], and the symbol 'u' represents the pair [u]/[ʊ]. Much like the previous graph, the distinction [ʉ]/[ɵ] pair is at ceiling level for almost all subjects, whereas the distinction [u]/[ʊ] is trivial for only half of the subjects. The difference [ʉ]/[ɵ] is easier to detect than the difference [u]/[ʊ].

Other vowel pairs are not significantly harder to distinguish than the pairs [ɑ]/[a] and [ʉ]/[ɵ]. The following chart provides the t-values and p-values, comparing the sensitivity indices distinguishing the difference between the vowel pair [ɑ]/[a] and other tense/lax vowel pairs.

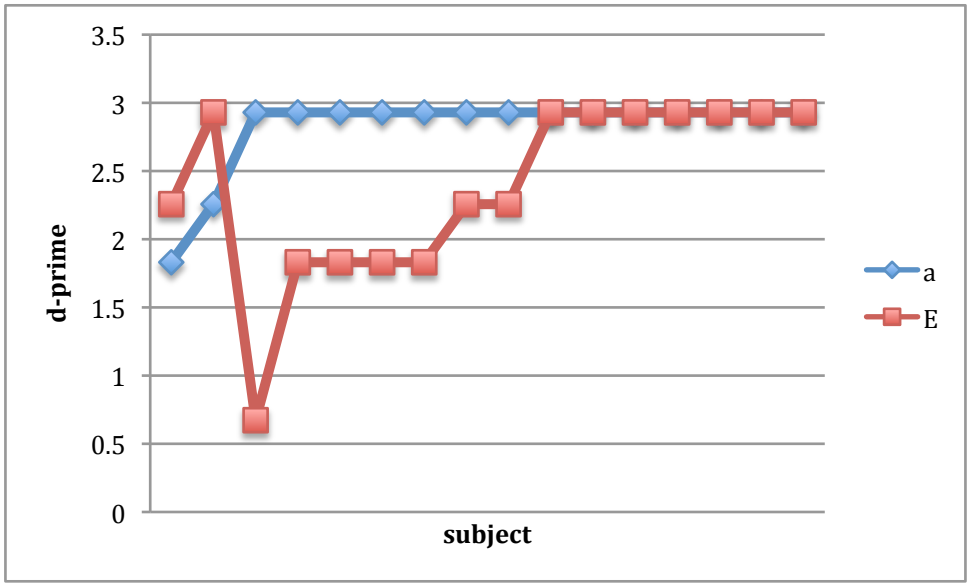
(420)

	[ɑ]/[a]	[ɛ]/[ɛ̝] vs. [ɑ]/[a]	[o]/[ɔ] vs. [ɑ]/[a]	[i]/[ɪ] vs. [ɑ]/[a]	[ø]/[ø̞] vs. [ɑ]/[a]	[e]/[ɛ̝] vs. [ɑ]/[a]	[y]/[ʏ] vs. [ɑ]/[a]
t(120)		-2.79	-0.54	-0.37	0.30	0.00	0.00
p		0.006	0.588	0.711	0.786	1.000	1.000
mean	2.82	2.39	2.74	2.76	2.78	2.82	2.82

The following six graphs illustrate the distribution of the sensitivity indices, comparing the vowel pair [ɑ]/[a] and other tense/lax vowel pairs.

The first chart compares the distribution of the vowel pair [ɑ]/[a] with the pair [ɛ]/[ɛ̝]. The symbol 'a' represents the pair [ɑ]/[a], and the symbol 'E' represents the pair [ɛ]/[ɛ̝].

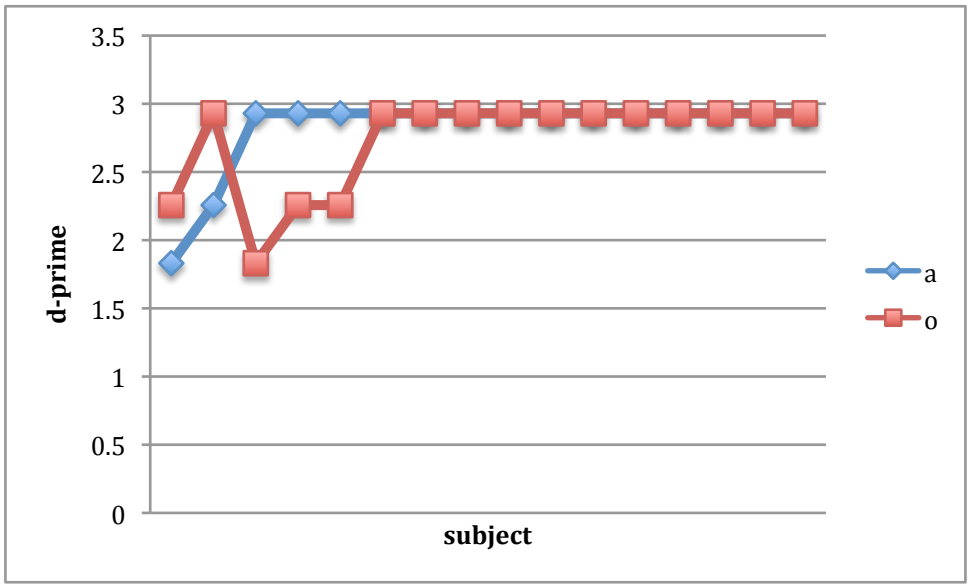
(421)

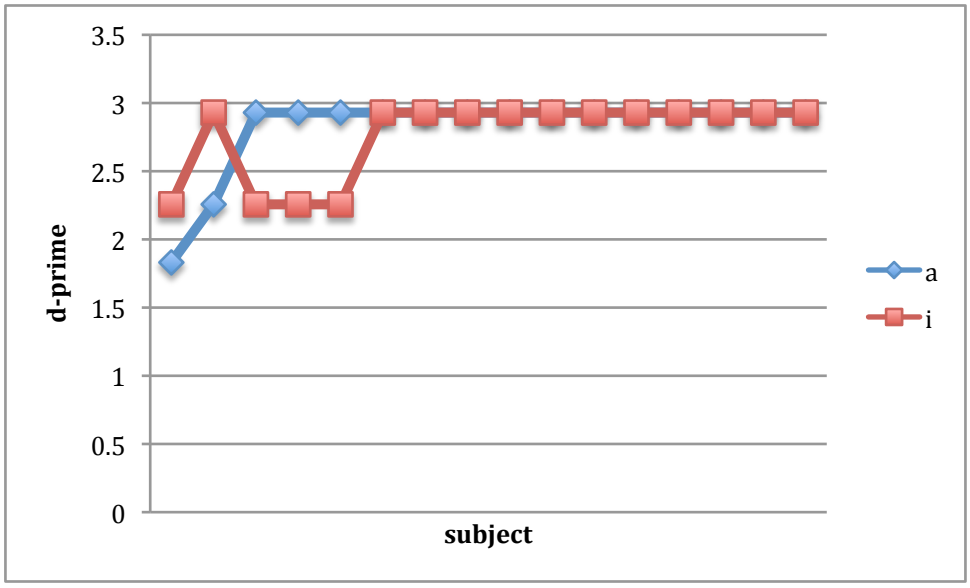


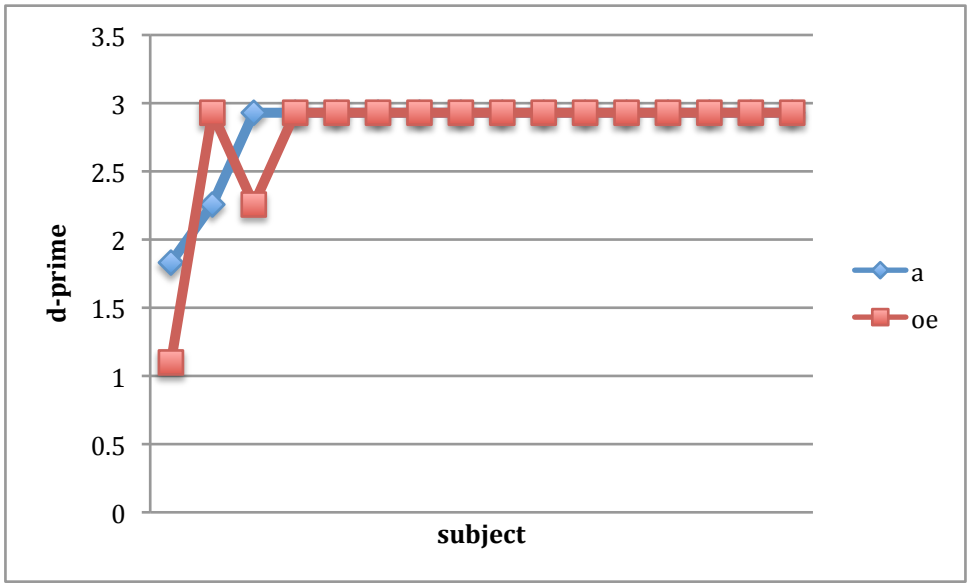
Subjects were clearly better at distinguishing the pair [ɑ]/[a] than the pair [ɛ]/[ɛ̝], but because of the Bonferroni adjustment of the alpha-value (14 pairwise comparisons were made), the p-value of 0.006 was nonsignificant.

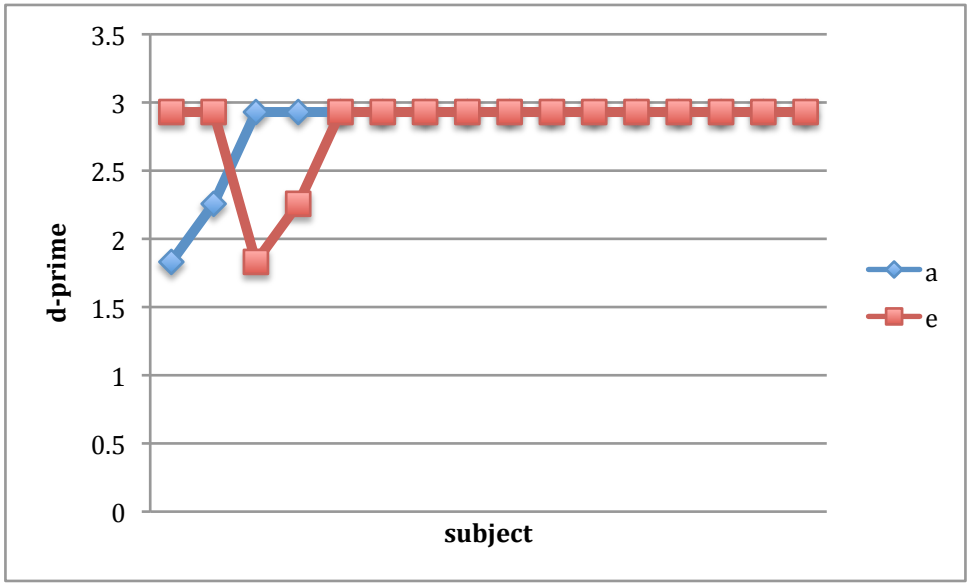
The next five charts compares the sensitivity index distinguishing the vowel pair [ɑ]/[a] (represented by 'a') with the pairs [o]/[ɔ] (represented by 'o'), [i]/[ɪ] (represented by 'i'), [ø]/[ø̞] (represented by 'oe'), [e]/[ɛ̝] (represented by 'e') and [y]/[ʏ] (represented by 'y'). Notice that the subjects perform at ceiling level in all of these cases.

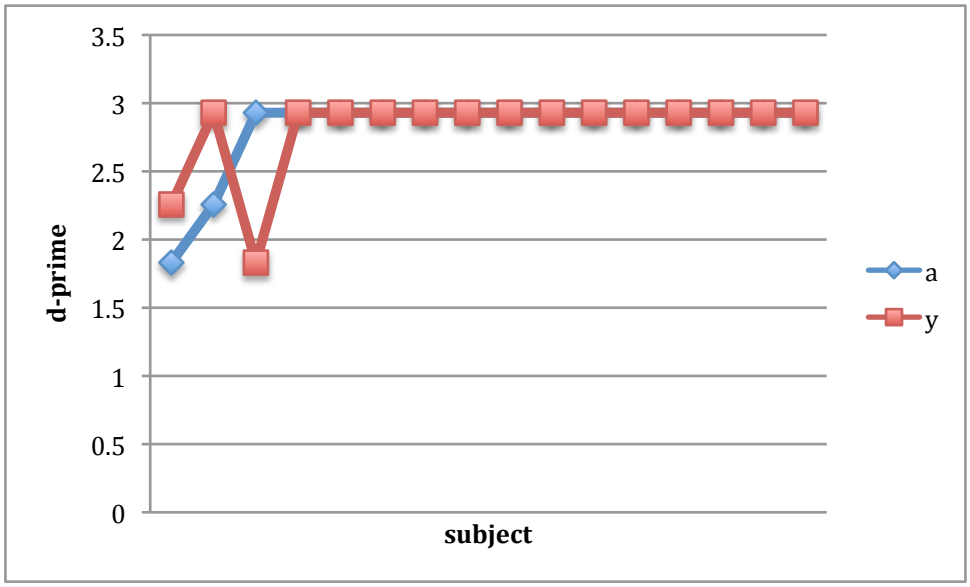
(422)


3.5
3
2.5
2
1.5
1
0.5
0
d-prime
subject
a
o


3.5
3
2.5
2
1.5
1
0.5
0
d-prime
subject
a
i


3.5
3
2.5
2
1.5
1
0.5
0
d-prime
subject
a
oe


3.5
3
2.5
2
1.5
1
0.5
0
d-prime
subject
a
e



Since the performance was at ceiling level with these vowel pairs, and it was at ceiling level with [ɑ]/[a], no significant difference was detected between these vowel pairs and [ɑ]/[a].

The following are the t-values and p-values, comparing the sensitivity indices distinguishing the difference between the vowel pair [ʉ]/[ɵ] and other tense/lax vowel pairs.

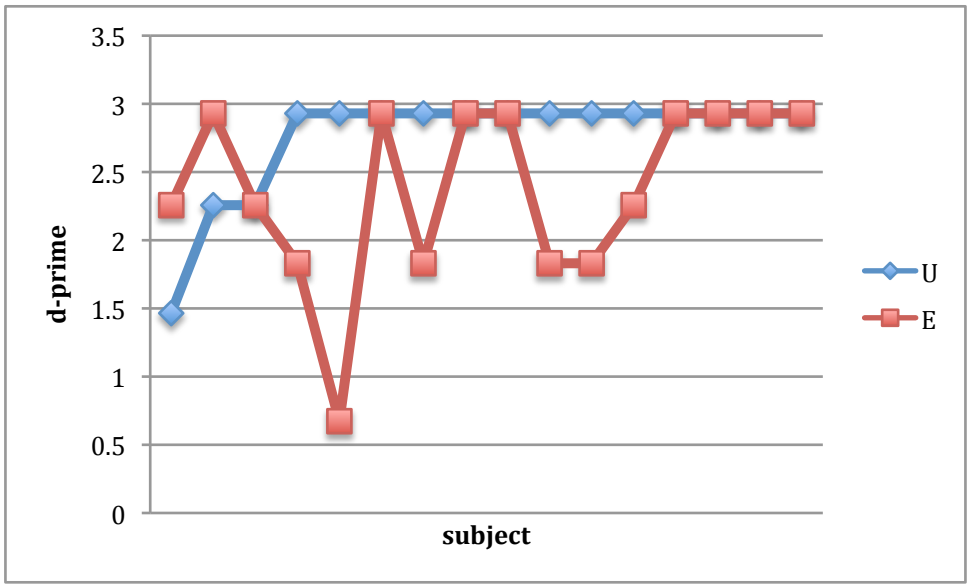
(423)

	[ʉ]/[ɵ]	[ɛ]/[ɛ̞] vs. [ʉ]/[ɵ]	[o]/[ɔ] vs. [ʉ]/[ɵ]	[ø]/[ø̞] vs. [ʉ]/[ɵ]	[i]/[ɪ] vs. [ʉ]/[ɵ]	[e]/[ɛ̞] vs. [ʉ]/[ɵ]	[y]/[ʏ] vs. [ʉ]/[ɵ]
t(120)		2.37	0.12	0.12	-0.05	-0.42	-0.42
p		0.019	0.901	0.901	0.962	0.675	0.675
Mean	2.75	2.39	2.74	2.78	2.76	2.82	2.82

The mean d′ of the pair [ʉ]/[ɵ] is only significantly higher than the mean d′ of the pair [ɛ]/[ɛ̞]; the mean d′ of the pair [ʉ]/[ɵ] is not significantly higher than that of the remaining vowel pairs in chart. In fact, it is lower than that of vowel pairs [i]/[ɪ], [ø]/[ø̞], [e]/[ɛ̞], and [y]/[ʏ].

The following six charts illustrate the distribution of the sensitivity indices, comparing the vowel pair [ʉ]/[ɵ] and other tense/lax vowel pairs. The first chart compares the distribution of the vowel pair [ʉ]/[ɵ] with the pair [ɛ]/[ɛ̞].

(424)

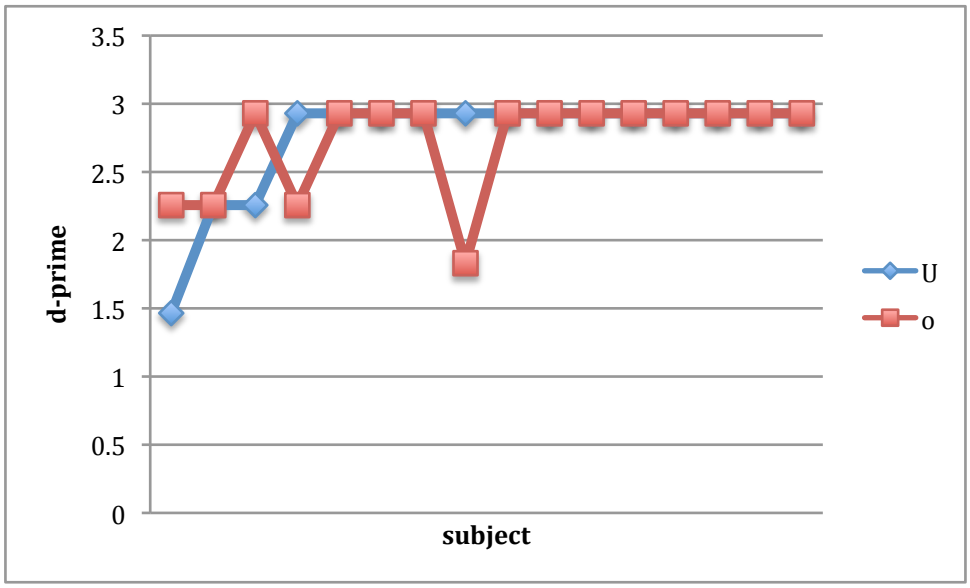


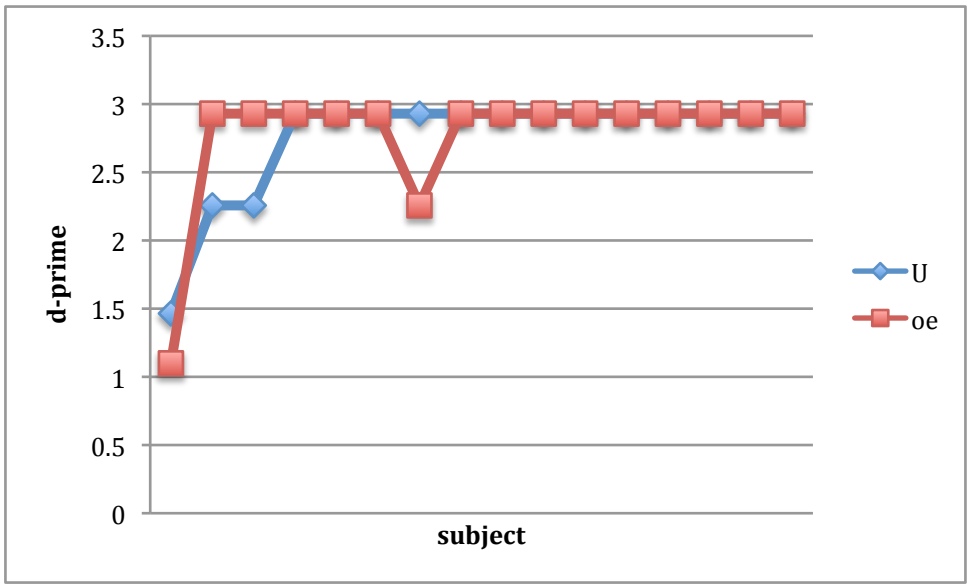
The symbol 'U' represents the pair [ʉ]/[ɵ], and the symbol 'E' represents the pair [ɛ]/[ɛ̞]. Generally the sensitivity index is higher in the vowel pair [ʉ]/[ɵ] than in the pair [ɛ]/[ɛ̞]; however, because of the Bonferroni correction with $\alpha = 0.004$, the difference was nonsignificant at $p = 0.019$.

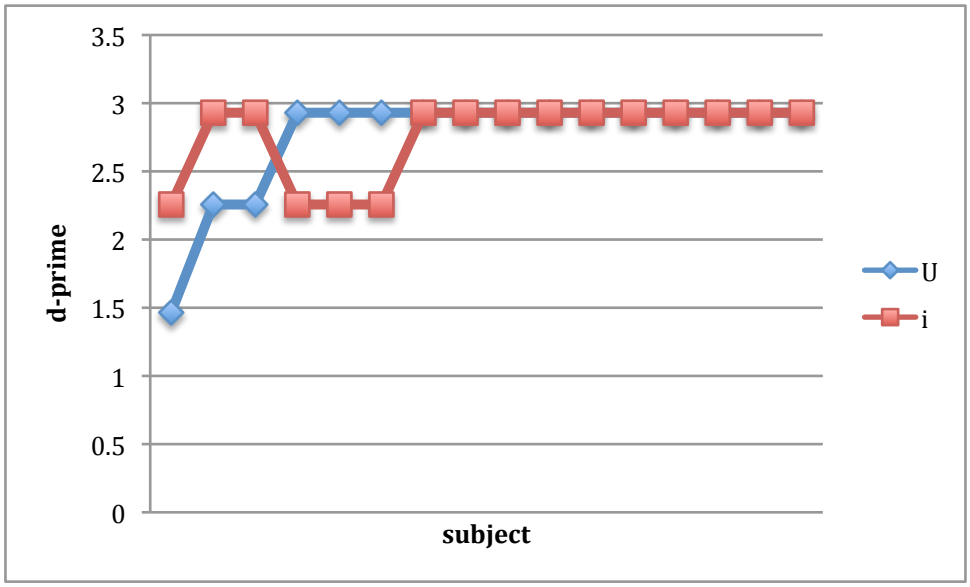
The next five charts illustrate the comparisons in sensitivity index between the vowel pair [ʉ]/[ɵ] and the pairs [o]/[ɔ] ('o'), [ø]/[ø̞] ('oe'), [i]/[ɪ] ('i'), [e]/[ɛ̞] ('e'), and

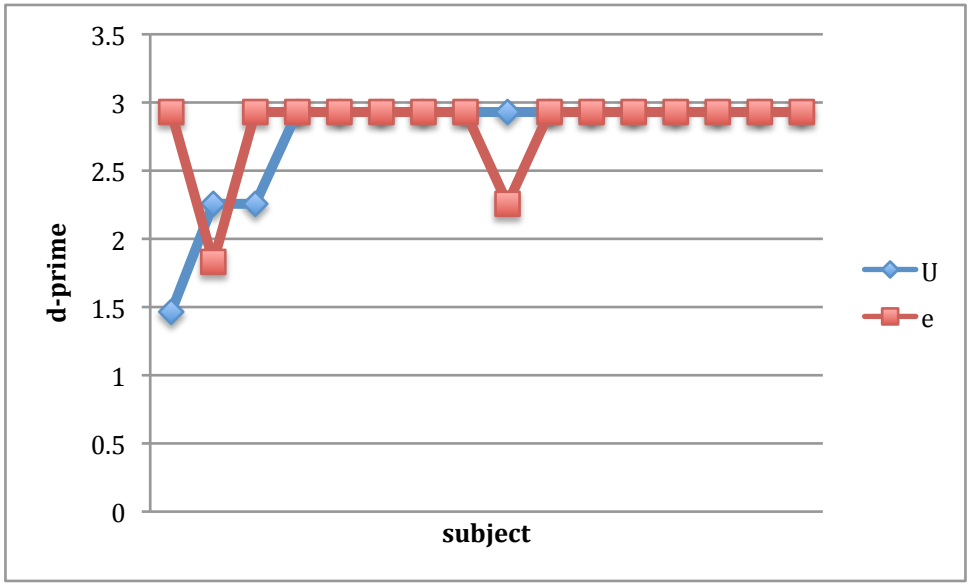
[y]/[ʏ] ('y'), respectively. Notice that the subjects perform near ceiling level in all of these cases.

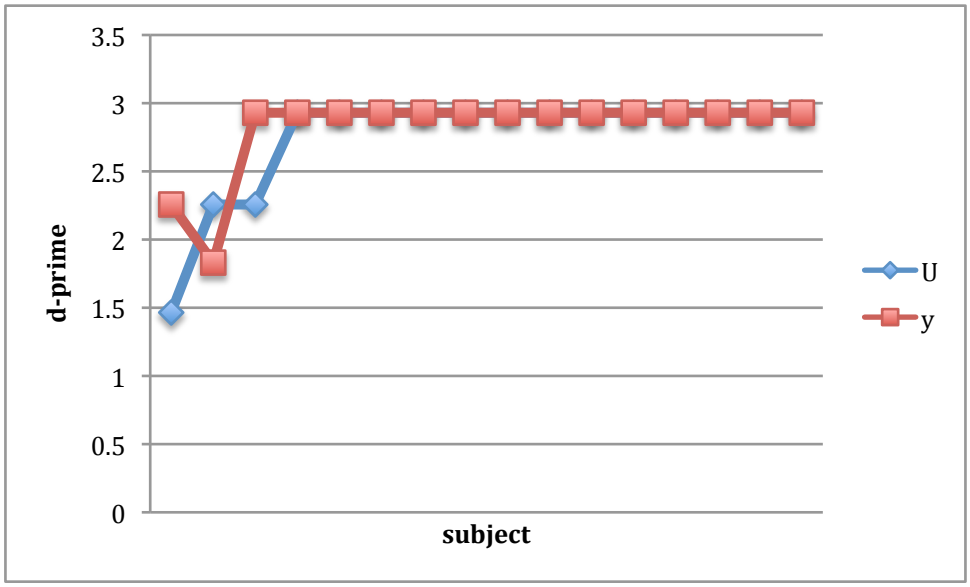
(425)






3.5
3
2.5
2
1.5
1
0.5
0
d-prime
subject
U
i


3.5
3
2.5
2
1.5
1
0.5
0
d-prime
subject
U
e



Since the performance was at ceiling level with these vowel pairs, and it was at ceiling level with [ʉ]/[ɵ], no significant difference was detected between these vowel pairs and [ʉ]/[ɵ]. The task was too easy for all these vowel pairs.

6.11.2 Reaction time analysis

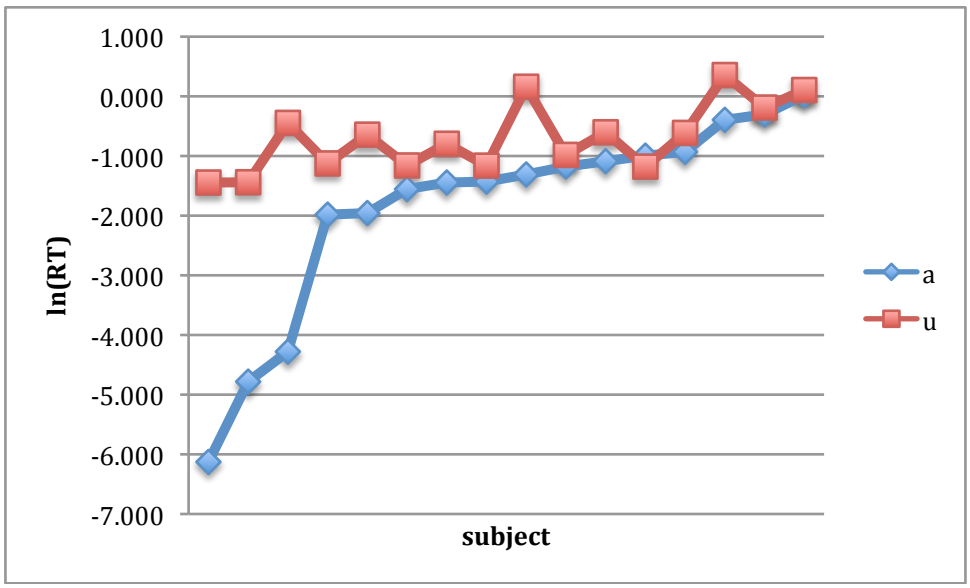
To verify whether different tense/lax pairs feature different RTs—thereby suggesting a difference in facility of discernment—an omnibus test was performed on the mean ln(RT)s of the various vowels. There was one independent variable, vowel type, with 9 levels (one for each tense/lax pair). There was one dependent variable, ln(RT). The result was $F(8, 120) = 7.47$; $p < 0.0001$.

The only vowels that showed RTs for the tense/lax pairs that were significantly different from the RTs of [ɑ]/[a] and [ʉ]/[ɵ] were the pairs [u]/[ʊ] and [ɛ]/ [ɛ̞]. Other tense/lax vowel pairs were not significantly different from [ɑ]/[a] and [ʉ]/[ɵ].

The mean ln(RT) of [ɑ]/[a] was -1.859 (i.e., 155 msec.); the mean ln(RT) for [ʉ]/[ɵ] was -2.215 (i.e., 109 msec.); the mean ln(RT) for [u]/[ʊ] was -0.698 (i.e., 498 msec.); and the mean ln(RT) for the pair [ɛ]/[ɛ̝] was -0.515 (i.e., 598 msec.).

The contrast between [ɑ]/[a]~ [u]/[ʊ] was significant, with $t(120) = 3.63$; and $p < 0.001$; $\alpha = 0.004$, with a Bonferroni adjustment.

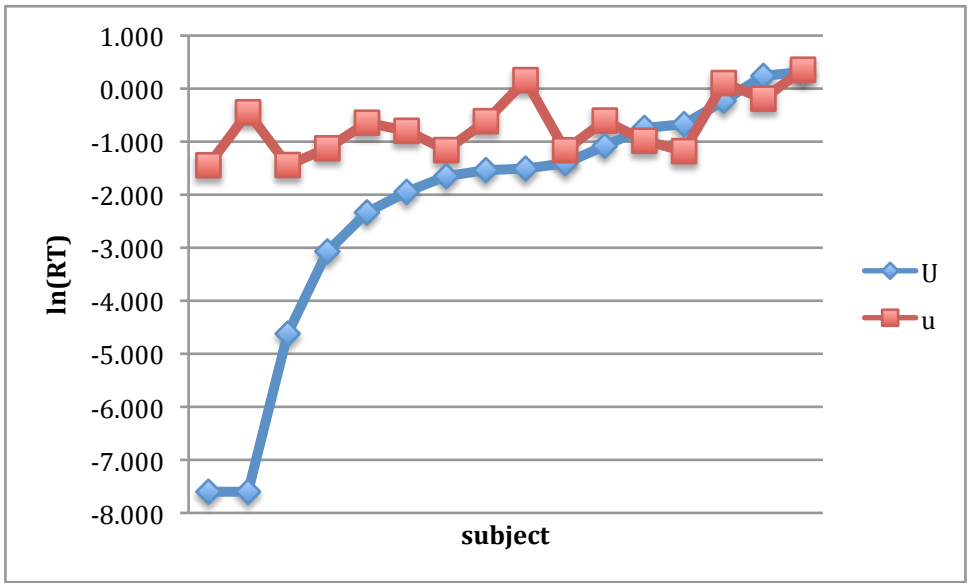
(426)



The pair [ɑ]/[a] is marked by 'a'; the pair [u]/[ʊ] is marked by 'u'. Notice that the tense/lax vowel pair [ɑ]/[a] has a consistently lower value than the tense/lax vowel pair [u]/[ʊ]. Less time is required to distinguish the pair [ɑ]/[a] than the pair [u]/[ʊ]. This is unsurprising, as a similar effect was established by d′ analysis.

Also the pair [ʉ]/[ɵ] was shown to be significantly easier to distinguish than the pair [u]/[ʊ], resulting in shorter reaction times for the former. The values obtained were $t(120) = -4.74$, with $p < 0.001$; $\alpha = 0.004$, with a Bonferroni adjustment.

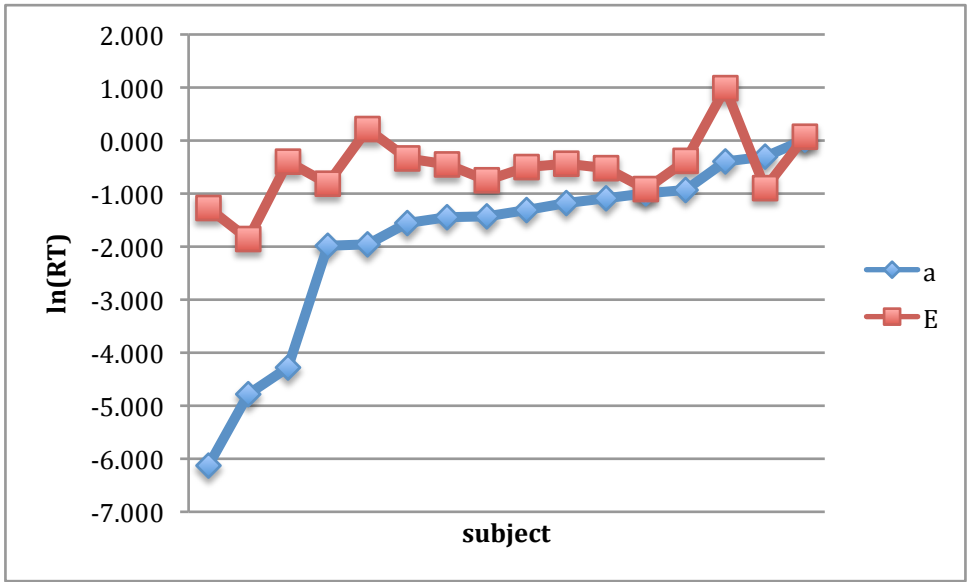
(427)



The pair [ʉ]/[ɵ] is marked by upper case 'U'; the pair [u]/[ʊ] is marked by lower case 'u'. The tense/lax vowel pair [ʉ]/[ɵ] has a consistently lower value than the tense/lax vowel pair [u]/[ʊ]. Less time is required to distinguish the pair [ʉ]/[ɵ] than the pair [u]/[ʊ]. This is expected, as a similar effect was established by d′ analysis.

The vowel pairs [ɑ]/[a] and [ɛ]/[ɛ̝] are also significantly different, with $t(120) = 4.20$ and $p < 0.001$; $\alpha = 0.004$, with a Bonferroni adjustment.

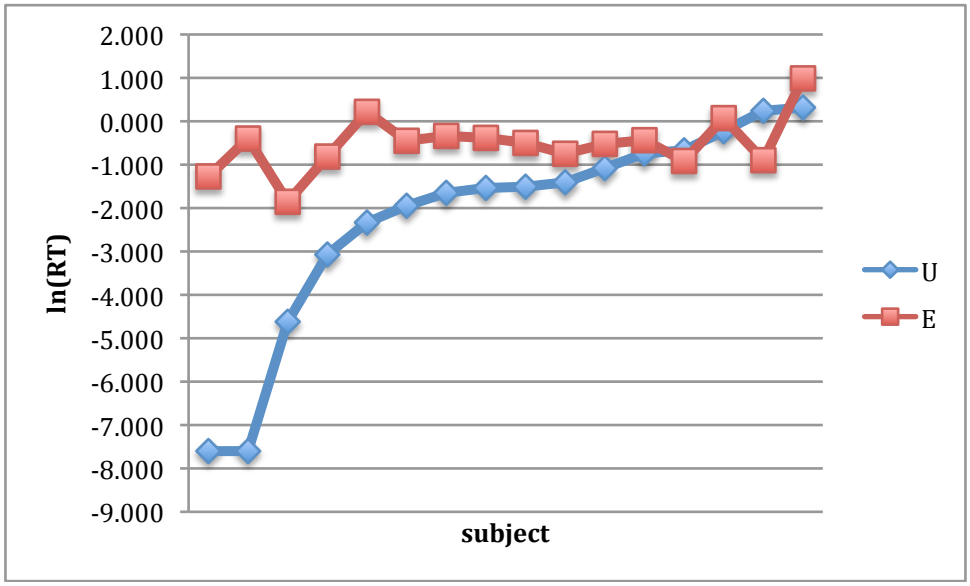
(428)



The pair [ɑ]/[a] is marked by 'a'; the pair [ɛ]/[ɛ̟] is marked by 'E'. The tense/lax vowel pair [ɑ]/[a], has a consistently lower value than the tense/lax vowel pair [ɛ]/[ɛ̟]. Less time is required to distinguish the pair [ɑ]/[a] than the pair [ɛ]/[ɛ̟].

A significant difference in RT was also found between the tense/lax pair [ʉ]/[ɵ] and the tense/lax pair [ɛ]/[ɛ̟], with $t(120) = -5.31$, and $p < 0.001$; $\alpha = 0.004$, with a Bonferroni adjustment.

(429)



The pair [ʉ]/[ɵ] is marked by 'U'; the pair [ɛ]/[ɛ̝] is marked by 'E'. The tense/lax vowel pair [ʉ]/[ɵ] has a consistently lower value than the tense/lax vowel pair [ɛ]/[ɛ̝]. Less time is required to distinguish the pair [ʉ]/[ɵ] than the pair [ɛ]/[ɛ̝].

So, the tense/lax vowel pairs [u]/[ʊ] and [ɛ]/[ɛ̝] are significantly more similar to each other than the tense/lax vowel pairs [ɑ]/[a] and [ʉ]/[ɵ], as revealed in differences in ln(RT).

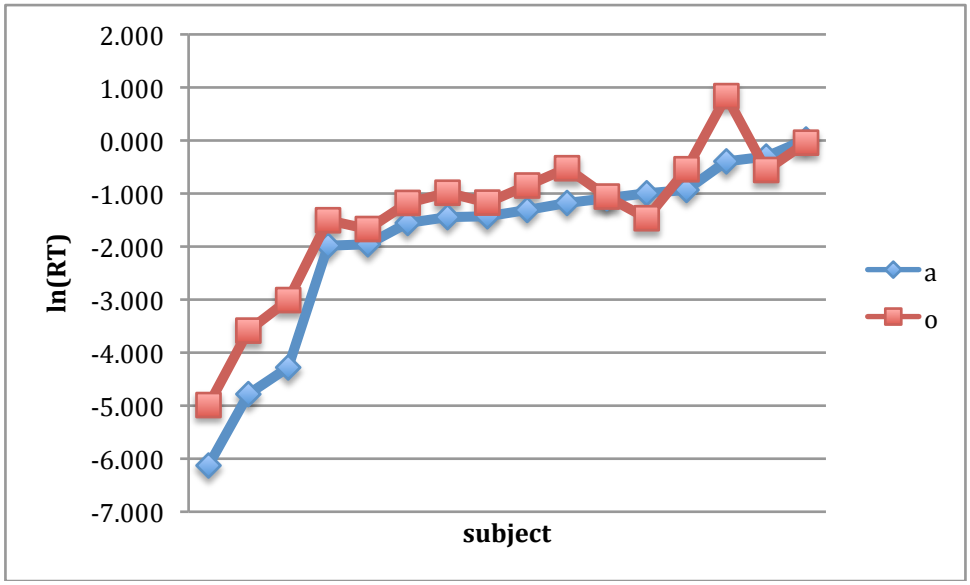
Other tense/lax vowel pairs do not differ significantly from [ɑ]/[a] and [ʉ]/[ɵ]. The t-values and p-values of these pairs as compared to [ɑ]/[a] are listed below:

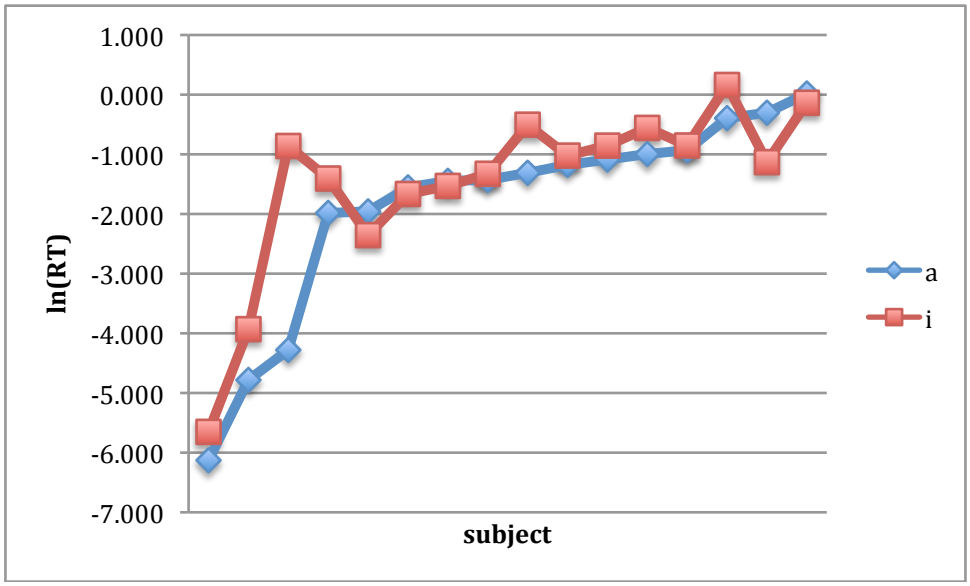
(430)

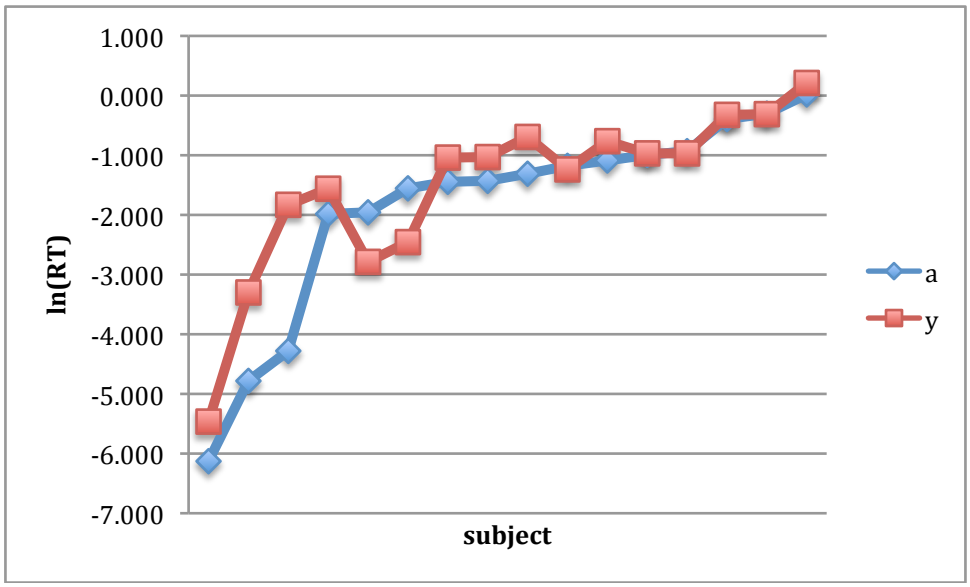
	[ɑ]/[a]	[o]/[ɔ] vs. [ɑ]/[a]	[i]/[ɪ] vs. [ɑ]/[a]	[y]/[ʏ] vs. [ɑ]/[a]	[e]/[ɛ̝] vs. [ɑ]/[a]	[ø]/[ø̞] vs. [ɑ]/[a]
t(120)		1.46	1.19	1.02	-0.72	-1.03
p		0.148	0.235	0.311	0.473	0.306
mean ln(RT)	-1.859	-1.393	-1.476	-1.533	-2.089	-2.187
＝msec	156	248	229	216	124	112

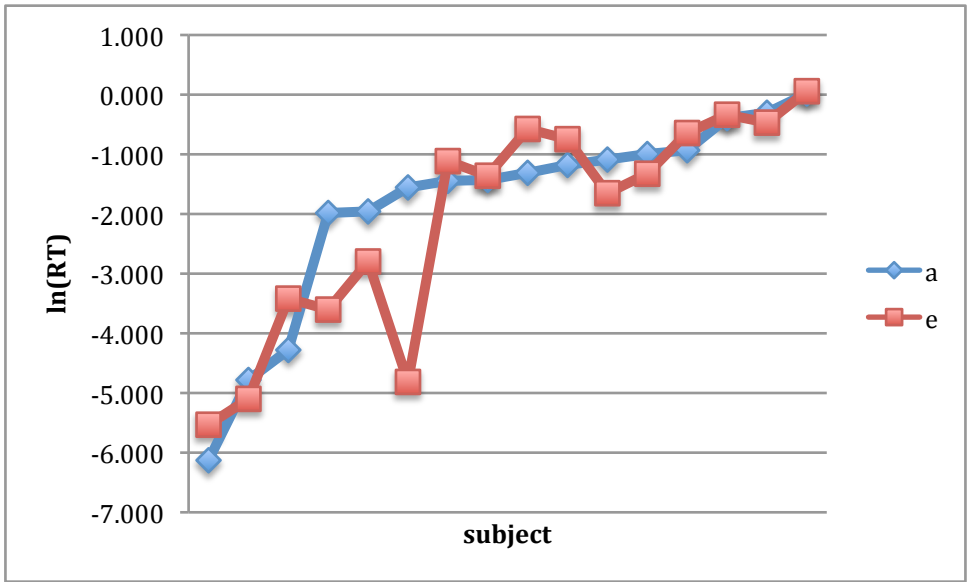
The following graphs illustrate how closely distributed the ln(RT)s were among these vowels. The pair [o]/[ɔ] is marked by 'o'; [i]/[ɪ] by 'i'; [y]/[ʏ] by 'y'; [e]/[ɛ̝] by 'e'; and [ø]/[ø̞] by 'oe'.

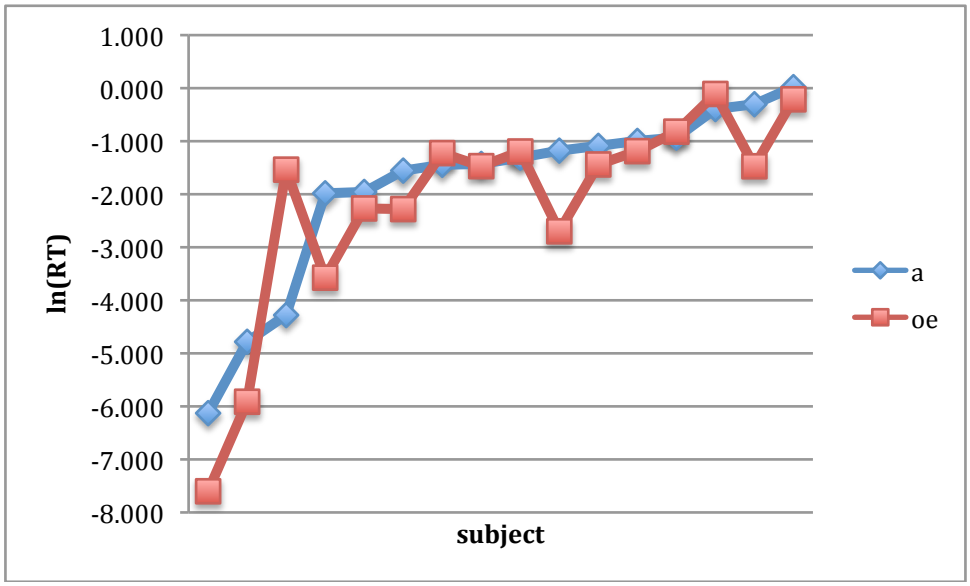
(431)




1.000
0.000
-1.000
-2.000
-3.000
-4.000
-5.000
-6.000
-7.000
ln(RT)
subject
a
i


1.000
0.000
-1.000
-2.000
-3.000
-4.000
-5.000
-6.000
-7.000
ln(RT)
subject
a
y





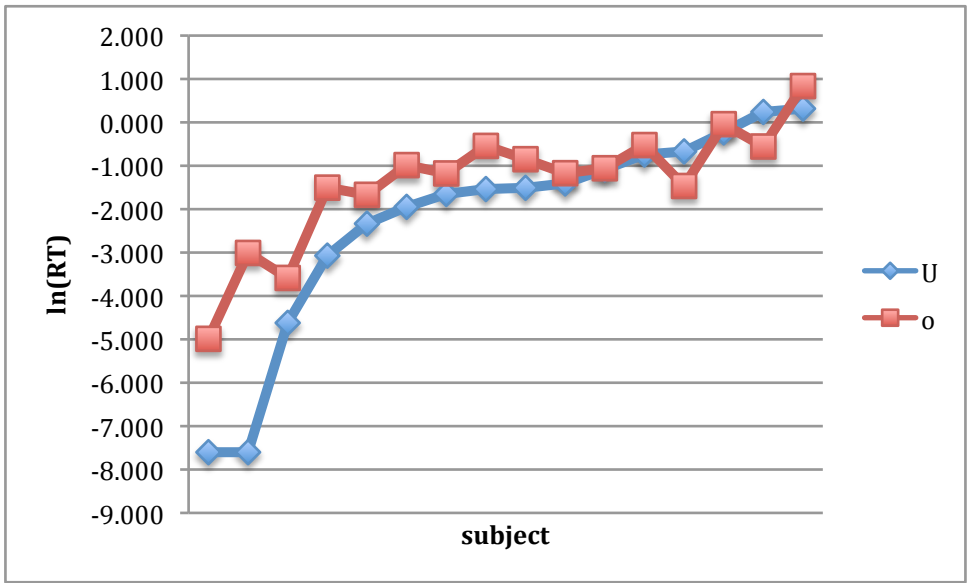
The following chart summarizes the t-values and the p-values of the ln(RT)s of the tense/lax vowel pairs which were not significantly different from the pair [ʉ]/[ɵ].

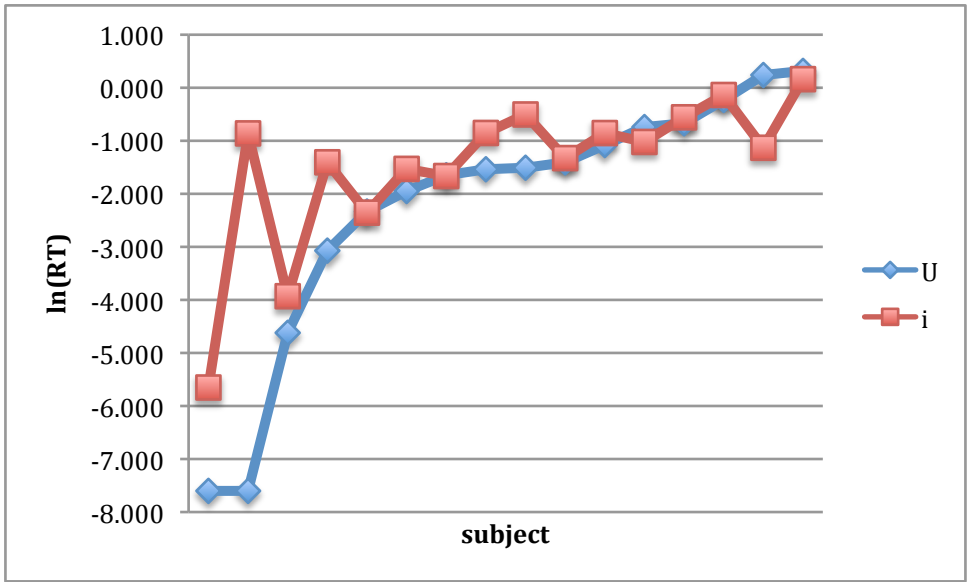
(432)

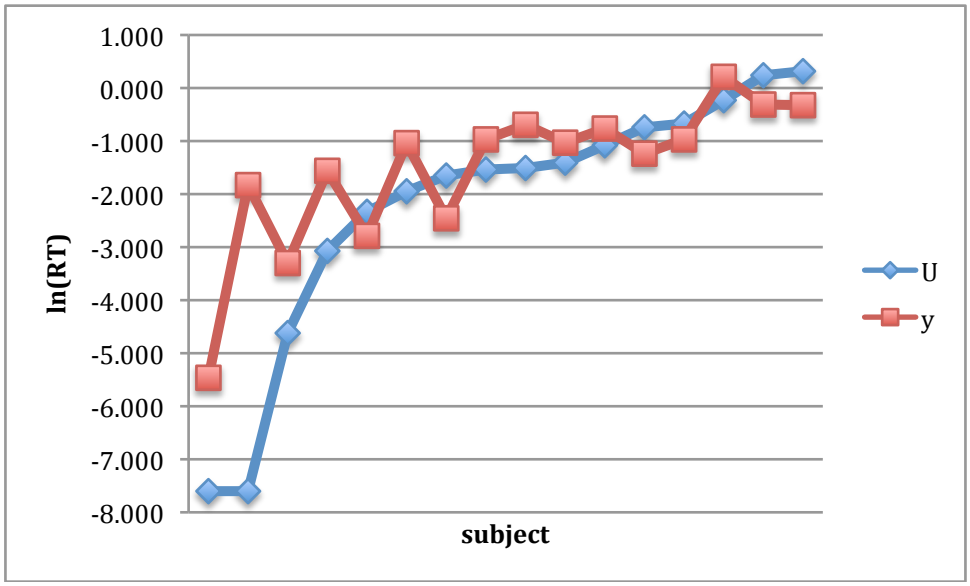
	[ʉ]/[ɵ]	[o]/[ɔ] vs. [ʉ]/[ɵ]	[i]/[ɪ] vs. [ʉ]/[ɵ]	[y]/[ʏ] vs. [ʉ]/[ɵ]	[e]/[ɛ̝] vs. [ʉ]/[ɵ]	[ø]/[œ̝] vs. [ʉ]/[ɵ]
t(120)		-2.57	-2.31	-2.13	-0.39	-0.09
p		0.011	0.023	0.035	0.694	0.932
mean ln(RT)	-2.215	-1.393	-1.476	-1.533	-2.089	-2.187
＝msec	109	248	229	216	124	112

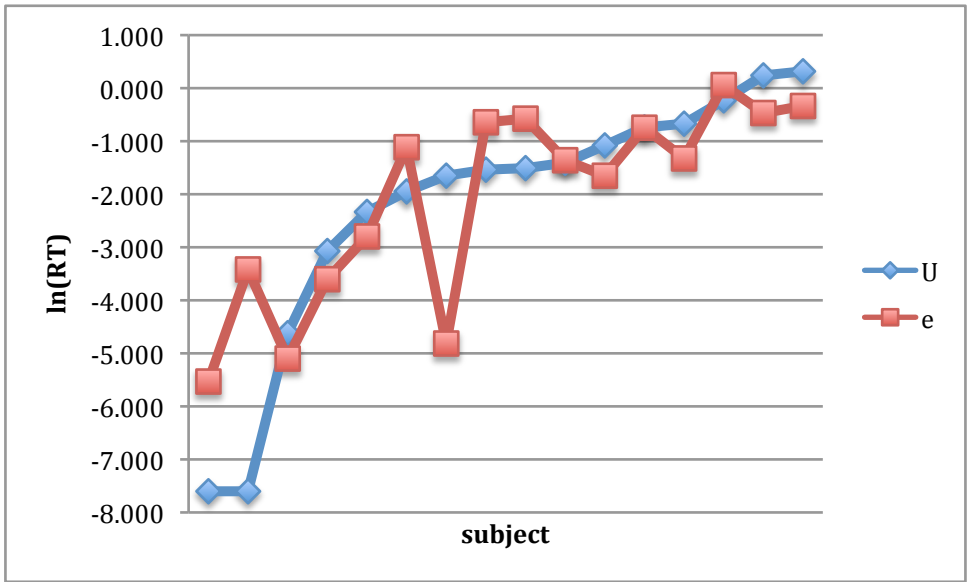
Note that the first three vowel pairs have ln(RT)s that are substantially higher than those of [ʉ]/[ɵ], with p-values well below 0.05. However, because 14 comparisons were made simultaneously, $\alpha = 0.004$ with a Bonferroni correction; so these differences are not statistically significant. In the following charts, the pair [o]/[ɔ] is marked by 'o'; [i]/[ɪ] by 'i'; [y]/[ʏ] by 'y'; [e]/[ɛ̝] by 'e'; and [ø]/[œ̝] by 'oe'.

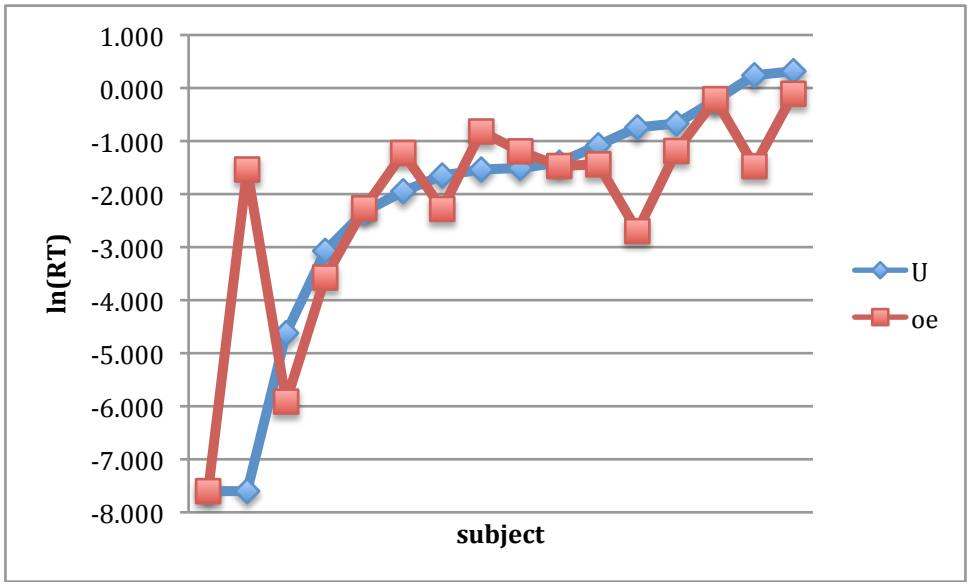
(433)


2.000
1.000
0.000
-1.000
-2.000
-3.000
-4.000
-5.000
-6.000
-7.000
-8.000
-9.000
ln(RT)
subject
U
o


1.000
0.000
-1.000
-2.000
-3.000
-4.000
-5.000
-6.000
-7.000
-8.000
ln(RT)
subject
U
i


1.000
0.000
-1.000
-2.000
-3.000
-4.000
-5.000
-6.000
-7.000
-8.000
ln(RT)
subject
U
y


1.000
0.000
-1.000
-2.000
-3.000
-4.000
-5.000
-6.000
-7.000
-8.000
ln(RT)
subject
U
e



As noted previously, the present experiment showed less than was intended: the hope was to show that the pairs [ɑ]/[a] and [ʉ]/[ɵ] featured a greater perceptual distance than all the other vowel pairs. It was only established that they featured a greater perceptual distance than the pairs [u]/[ʊ] and [ɛ]/[ɛ̞]. The other vowels do not contradict the thesis; they simply yield a null result.

The d′ results revealed ceiling effects for almost all the vowels; clearly the task was too easy. An additional challenge or distraction should be introduced to this task to make it more challenging; perhaps a d′ effect could then be noticed.

In addition, a fundamental problem in the design of the experiment rendered the experiment insufficiently sensitive to differences in RTs. The specific error was having the timer start at the end of the stimulus, instead of having it start at the beginning of the stimulus. Since the stimuli in this experiment were of the form hVt, vowel formant information was already present in the onset /h/: many subjects therefore identified the stimulus correctly as ‘same’ or ‘different’ well before the timer started. This resulted in either RTs of zero (if the mouse button was kept pressed until the timer started), or no

RT at all (if the mouse button was released before the timer started). If this experiment is performed again in the future, this fundamental error must be fixed; I do not doubt that further significant results can be obtained this way.

6.11.3 Section overview

In this section, d′ analysis and RT analysis was undertaken, to assess whether the vocalic distances in Chapter 4 are accurate. In particular, the question was whether the tense/lax pairs [ɑ]/[a] and [ʉ]/[ɵ] are more distant than other tense/lax pairs in the Swedish language. It was found that these two vowels feature a significantly greater perceptual distance than two other tense/lax pairs. In particular, d′ analysis established that both [ɑ]/[a] and [ʉ]/[ɵ] are more distant than the pair [u]/[ʊ]. This finding was independently established through RT analysis. RT analysis established furthermore that both [ɑ]/[a] and [ʉ]/[ɵ] are more distant than the tense/lax pair [ɛ]/[ɛ̝].
Other tense/lax pairs were not found to be significantly less distant than [ɑ]/[a] and [ʉ]/[ɵ].

6.12 Local summary

This chapter discusses five experiments, intended to establish P-maps used throughout the dissertation.

The first experiment involved the detection of [n] in post-nasal, post-lateral, and post-vocalic position. d′ analysis established a significant difference between the post-nasal and post-lateral conditions. RT analysis with analytical weights established a three-way distinction between the three conditions: it takes more time to discern the sound [n] in post-nasal position than in post-lateral position; and post-lateral position takes more time than post-vocalic position.

The second experiment involved the distinction between [ən] and [an], as well as between [ən] and [ɔn]. d′ analysis revealed that the difference [ən]/[an] is more difficult to discern than the difference [ən]/[ɔn]. Similarly, RT analysis revealed the distinction [ən]/[an] takes more time to discern than the distinction [ən]/[ɔn].

The third experiment involved repetition blindness in sequences like [ənən], [anən], and [ɔnən]; they were compared to sequences without final [ən]; that is, [ən], [an], and [ɔn]. d′ analysis revealed that the pair [ənən]/[ən] was more confusable than [anən]/[an] and [ɔnən]/[ɔn]. RT analysis revealed no significant results.

The fourth experiment involved perceptibility of degemination in post-consonantal and post-vocalic position. d′ analysis revealed that degemination in post-vocalic position is significantly easier to discern than in post-consonantal position. No significant result was found in RT analysis.

The fifth experiment involved the perceptual distance between tense/lax vowel pairs in Swedish. d′ analysis revealed that vowel pairs [ɑ, a] and [ʉ, ɵ] were more reliably distinguished than the vowel pair [u, ʊ]. Other vowel pairs were not significantly different from [ɑ, a] and [ʉ, ɵ]. RT analysis revealed that vowel pairs [ɑ, a] and [ʉ, ɵ] were more quickly discerned than the vowel pairs [u, ʊ] and [e, ɛ]. Other vowel pairs were not significantly different from [ɑ, a] and [ʉ, ɵ].

7 Conclusion

The present thesis has two goals. The local goal is to solve classic puzzles of Swedish phonology. The global goal is to extend the role of perceptual distance (and similarity) in phonology and morphology, with a significant excursus into the role of frequency in unfaithful mapping.

Consider the local issue. Four puzzles of Swedish phonology have eluded explanation: first, the distribution of the definite suffix /n/; second, the distribution of long-consonant initial suffixes like past /dːe/; third, paradigm gaps in words like [lɑːt] 'lazy', which has no neuter form (Raffelsiefen 2002); fourth, the paradigmatic differences between phonotactically similar words like [grɑːd] 'straight' (with no neuter form) and [glɑːd] 'glad' (with an overt neuter form).

I have surmounted the local puzzles by positing five generalizations. The first two involve maintenance of distinctness in different parts of the grammar:

1 It is preferable for tautoparadigmatic affixes (including null suffixes) to be relatively distinct with respect to each other (Chapter 1). This penalizes similarity, not just homophony.

2 Identical sequences are avoided (haplology), but so are highly similar sequences. (Chapter 2).

The third and fourth generalizations involve correspondence between instances of the same morpheme: salient alternations are avoided.

3 Less salient alternation of consonant length is preferred to more salient alternation of consonant length (Chapter 3). This means that degemination is more likely to occur in those contexts where degemination is less noticeable.

4 Minimal alternation of vowel quality is preferred within paradigms (Chapter 4). The more distant two sounds are, the less likely their correspondence is. In the case discussed above, this results in paradigm gaps.

The fifth principle relates unfaithful mapping to morpheme frequency.

5 Severity of penalty of unfaithful mapping declines as the frequency of a morpheme increases (Chapter 5). Frequent morphemes can be paradigmatically altered to a greater extent than infrequent words.

Claims 1-5 were largely supported experimentally (Chapter 6).

Surveying these innovations in the broader context of phonological theory, present contributions include the following:

- Allomorphy is perceptually based.
- Haplology is a gradient phonetic phenomenon.
- Intraparadigmatic correspondence is perceptually based.
- Intraparadigmatic correspondence refers to frequency indices.

The first three of these observations imply that the grammar includes phonetic content (Fleischhacker 2005; Hume & Johnson 2001; Hayes, Kirchner & Steriade 2004; Kawahara 2006; Wilson 2006), and this extends into morphophonology and morphology. The fourth observation means that frequency is available to the grammar, and is not a mere performance phenomenon (in contrast to Bybee 2001). The phonetic claims appealed to by these analyses are largely supported by experimental results in Chapter 6.

Thus, these five case studies from Swedish shed light on theoretical controversies in generative phonology.

8 Appendices

8.1 Appendix 1: C_0V stems in regular 3rd conjugation as listed in *SAG* (1999:560-1)

STEM = INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[ˈbuː]	[ˈbʊtː]	[ˈbʊdː]	[ˈbʊdːə]	‘live’
[ˈbəruː]	[ˈbərʊtː]	[ˈbərʊdː]	[ˈbərʊdːə]	‘depend’
[ˈgluː]	[ˈglʊtː]	[ˈglʊdː]	[ˈglʊdːə]	‘stare’
[ˈgnuː]	[ˈgnʊtː]	[ˈgnʊdː]	[ˈgnʊdːə]	‘rub’
[ˈgruː]	[ˈgrʊtː]	[ˈgrʊdː]	[ˈgrʊdːə]	‘sprout’
[ˈruː]	[ˈrʊtː]	[ˈrʊdː]	[ˈrʊdːə]	‘row’
[ˈskuː]	[ˈskʊtː]	[ˈskʊdː]	[ˈskʊdːə]	‘shoe (a horse) ’
[ˈsnuː]	[ˈsnʊtː]	[ˈsnʊdː]	[ˈsnʊdːə]	‘twist’
[ˈtruː]	[ˈtrʊtː]	[ˈtrʊdː]	[ˈtrʊdːə]	‘believe’
[ˈfloː]	[ˈflɔtː]	[ˈflɔdː]	[ˈflɔdːə]	‘flay’
[ˈføːrəˌbroː]	[ˈføːrəˌbrɔtː]	[ˈføːrəˌbrɔdː]	[ˈføːrəˌbrɔdːə]	’reproach’
[førmoː]	[førmɔtː]	[førmɔdː]	[førmɔdːə]	‘manage’
[førsmoː]	[førsmɔtː]	[førsmɔdː]	[førsmɔdːə]	‘disdain’
[ˈkloː]	[ˈklɔtː]	[ˈklɔdː]	[ˈklɔdːə]	‘thrash’
[ˈmoː]	[ˈmɔtː]	[ˈmɔdː]	[ˈmɔdːə]	‘feel’
[ˈnoː]	[ˈnɔtː]	[ˈnɔdː]	[ˈnɔdːə]	‘reach’
[roː]	[rɔtː]	[rɔdː]	[rɔdːə]	‘help it’
[ˈspoː]	[ˈspɔtː]	[ˈspɔdː]	[ˈspɔdːə]	‘predict’
[ˈsoː]	[ˈsɔtː]	[ˈsɔdː]	[ˈsɔdːə]	‘sow’
[ˈtvoː]	[ˈtvɔtː]	[ˈtvɔdː]	[ˈtvɔdːə]	‘wash’
[ˈbryː]	[ˈbrʏtː]	[ˈbrʏdː]	[ˈbrʏdːə]	‘care’

[ˈfly:]	[ˈflʏt:]	[ˈflʏd:]	[ˈflʏd:ə]	‘flee’
[ˈgny:]	[ˈgnʏt:]	[ˈgnʏd:]	[ˈgnʏd:ə]	‘roar’
[ˈgry:]	[ˈgrʏt:]	[ˈgrʏd:]	[ˈgrʏd:ə]	‘dawn’
[ˈɧy:]	[ˈɧʏt:]	[ˈɧʏd:]	[ˈɧʏd:ə]	‘avoid’
[ˈsy:]	[ˈsʏt:]	[ˈsʏd:]	[ˈsʏd:ə]	‘sew’
[ˈspy:]	[ˈspʏt:]	[ˈspʏd:]	[ˈspʏd:ə]	‘vomit’
[ˈty:]	[ˈtʏt:]	[ˈtʏd:]	[ˈtʏd:ə]	‘seek out’
[ˈɧe:]	[ˈɧɛ̞t:]	[ˈɧɛ̞d:]	[ˈɧɛ̞d:ə]	‘occur’
[ˈte:]	[ˈtɛ̞t:]	[ˈtɛ̞d:]	[ˈtɛ̞d:ə]	‘appear’
[bəte:]	[bətɛ̞t:]	[bətɛ̞d:]	[bətɛ̞d:ə]	‘behave’
[bre:]	[brɛ̞t:]	[brɛ̞d:]	[brɛ̞d:ə]	‘spread’
[klɛ:]	[klɛ̞t:]	[klɛ̞d:]	[klɛ̞d:ə]	‘clothe’
[spɛ:]	[spɛ̞t:]	[spɛ̞d:]	[spɛ̞d:ə]	‘dilute’
[trɛ:]	[trɛ̞t:]	[trɛ̞d:]	[trɛ̞d:ə]	‘thread’
[ˈstrø:]	[ˈstrøt:]	[ˈstrød:]	[ˈstrød:ə]	‘sprinkle’
[føʂˈʈrø:]	[føʂˈʈrøt:]	[føʂˈʈrød:]	[føʂˈʈrød:ə]	‘divert’

8.2 Appendix 2: Irregular C_0V stems as listed in *SAG* (1999:570)

STEM	SUPINE	GLOSS
[be:]	[bɛ̞t:]	‘pray’
[je:]	[jɛ̞t:]	‘give’
[le:]	[lɛ̞t:]	‘smile’
[se:]	[sɛ̞t:]	‘see’
[fo:]	[fɔt:]	‘get’

[goː]	[gɔtː]	‘walk’
[stoː]	[stɔtː]	‘stand’
[døː]	[dø̞tː]	‘die’

Colloquial (non-standard) examples (*SAG* 1999:371):

STEM	SUPINE	GLOSS
[tɑː]	[tatː]	‘take’
[drɑː]	[dratː]	‘pull’
[bliː]	[blɪtː]	‘become’
[sloː]	[slɔtː]	‘hit’ (colloquial)

An exceptional word with [ɑː, a] correspondence

STEM	PRETERITE	GLOSS
[hɑː]	[hadːə]	‘have’

8.3 Appendix 3: C_0Vd stems in 2nd conjugation

as listed in Holmes & Hinchliffe 2003 (*SAG* 1999 does not provide a list.)

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bəˈtyːda]	[bəˈtʏtː]	[bəˈtʏdː]	[bəˈtʏdːə]	‘mean’
[ˈanˌtyːda]	[ˈanˌtʏtː]	[ˈanˌtʏdː]	[ˈanˌtʏdːə]	‘hint’
[ˈpryːda]	[ˈprʏtː]	[ˈprʏdː]	[ˈprʏdːə]	‘adorn’
[ˈtyːda]	[ˈtʏtː]	[ˈtʏdː]	[ˈtʏdːə]	‘interpret’

[ˈføːda]	[ˈfø̞tː]	[ˈfø̞dː]	[ˈfø̞dːə]	‘give birth’
[ˈgløːda]	[ˈgløt̞ː]	[ˈglød̞ː]	[ˈglød̞ːə]	‘glow’
[ˈleːda]	[ˈlɛ̝tː]	[ˈlɛ̝dː]	[ˈlɛ̝dːə]	‘lead’[90]

8.4 Appendix 4: C_0Vt stems in 2nd conjugation

as listed in Holmes & Hinchliffe 2003 (*SAG* 1999 does not provide a list.)

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[ˈɧøːta]	[ˈɧø̞tː]	[ˈɧø̞tː]	[ˈɧø̞tːə]	‘look after’
[ˈstøːta]	[ˈstø̞tː]	[ˈstø̞tː]	[ˈstø̞tːə]	‘prod’
[ˈmøːta]	[ˈmø̞tː]	[ˈmø̞tː]	[ˈmø̞tːə]	‘meet’
[ˈbyːta]	[ˈbʏtː]	[ˈbʏtː]	[ˈbʏtːə]	‘exchange’
[ˈmɛːta]	[ˈmɛ̝tː]	[ˈmɛ̝tː]	[ˈmɛ̝tːə]	‘measure’

8.5 Appendix 5: Regular C_0V adjectival stems

as listed in Holmes & Hinchliffe 2003

STEM	NEUTER	GLOSS
[bloː]	[blɔtː]	‘blue’
[groː]	[grɔtː]	‘grey’
[roː]	[rɔtː]	‘raw’
[nyː]	[nʏtː]	‘new’

[90] The word is not explicitly listed in Holmes & Hinchliffe 2003, but it follows the relevant pattern.

[friː]	[frɪtː]	‘free’
[sløː]	[sl̥øtː]	‘lazy’

8.6 Appendix 6: Regular C_0Vd adjectival stems as listed in Sigurd (1965:103)

STEM	NEUTER	GLOSS
[sʊˈliːd]	[sʊˈlɪtː]	‘solid’
[bliːd]	[blɪtː]	‘mild’
[viːd]	[vɪtː]	‘wide’
[striːd]	[strɪtː]	‘violent’
[røːd]	[r̥øtː]	‘red’
[sprøːd]	[sprøtː]	‘crisp’
[døːd]	[d̥øtː]	‘dead’
[breːd]	[br̥ɛtː]	‘broad’
[sneːd]	[sn̥ɛtː]	‘slanted’
[spɛːd]	[sp̥ɛtː]	‘tender’
[glɑːd]	[glatː]	‘happy’

8.7 Appendix 7: Regular C_0Vt adjectival stems as listed in Holmes & Hinchliffe 2003 and Sigurd (1965:102)

STEM	NEUTER	GLOSS
[heːt]	[h̥ɛtː]	‘hot’
[feːt]	[f̥ɛtː]	‘greasy, fat’
[slɛːt]	[sl̥ɛtː]	‘smooth’
[tɛːt]	[t̥ɛtː]	‘tight’

[voːt]	[vɔtː]	‘wet’
[viːt]	[vɪtː]	‘white’
[søːt]	[søtː]	‘sweet’
[bløːt]	[bløtː]	‘wet’

8.8 Appendix 8: C_0V(D) stems in first conjugation featuring [ɑ] or [ʉ] as listed in Gellerstam 1998 (*SAOL*)

C_0ɑː --

C_0ʉː

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bʉːa]	[bʉːat]	[bʉːad]	[bʉːadə]	‘boo’,
[dʉːa]	[dʉːat]	[dʉːad]	[dʉːadə]	‘to say ‘you’’
[mʉːa]	[mʉːat]	[mʉːad]	[mʉːadə]	‘moo’,
[frʉːa]	[frʉːat]	[frʉːad]	[frʉːadə]	‘call s.o. *Mrs.*’

C_0ɑːd

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bɑːda]	[bɑːdat]	[bɑːdad]	[bɑːdadə]	‘bathe’
[skɑːda]	[skɑːdat]	[skɑːdad]	[skɑːdadə]	‘harm’
[blɑːda]	[blɑːdat]	[blɑːdad]	[blɑːdadə]	‘pick leaves’
[rɑːda]	[rɑːdat]	[rɑːdad]	[rɑːdadə]	‘line up’
[grɑːda]	[grɑːdat]	[grɑːdad]	[grɑːdadə]	‘put together’
[vɑːda]	[vɑːdat]	[vɑːdad]	[vɑːdadə]	‘wade’

C_0ʉːd

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bʉːda]	[bʉːdat]	[bʉːdad]	[bʉːdadə]	‘call’
[ɑːvgʉːda]	[ɑːvgʉːdat]	[ɑːvgʉːdad]	[ɑːvgʉːdadə]	‘deify’
[førgʉːda]	[førgʉːdat]	[førgʉːdad]	[førgʉːdadə]	‘deify’

C_0ɑːt

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[hɑːta]	[hɑːtat]	[hɑːtad]	[hɑːtadə]	‘hate’
[çɑːta]	[çɑːtat]	[çɑːtad]	[çɑːtadə]	‘pester’
[lɑːta]	[lɑːtat]	[lɑːtad]	[lɑːtadə]	‘be idle’
[mɑːta]	[mɑːtat]	[mɑːtad]	[mɑːtadə]	‘feed’
[gnɑːta]	[gnɑːtat]	[gnɑːtad]	[gnɑːtadə]	‘argue’
[knɑːt-a]	[knɑːtat]	[knɑːtad]	[knɑːtadə]	‘run’
[rɑːta]	[rɑːtat]	[rɑːtad]	[rɑːtadə]	‘reject’
[prɑːta]	[prɑːtat]	[prɑːtad]	[prɑːtadə]	‘talk’

C_0ʉ:t

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[hʉ:ta]	[hʉ:tat]	[hʉ:tad]	[hʉ:tadə]	‘correct’
[kʉ:ta]	[kʉ:tat]	[kʉ:tad]	[kʉ:tadə]	‘run’
[lʉ:ta]	[lʉ:tat]	[lʉ:tad]	[lʉ:tadə]	‘lean’
[klʉ:ta]	[klʉ:tat]	[klʉ:tad]	[klʉ:tadə]	‘disguise’,
[plʉ:ta]	[plʉ:tat]	[plʉ:tad]	[plʉ:tadə]	‘pout’
[slʉ:ta]	[slʉ:tat]	[slʉ:tad]	[slʉ:tadə]	‘stop’
[mʉ:ta]	[mʉ:tat]	[mʉ:tad]	[mʉ:tadə]	‘bribe’
[pʉ:ta]	[pʉ:tat]	[pʉ:tad]	[pʉ:tadə]	‘bulge’
[inrʉ:ta]	[inrʉ:tat]	[inrʉ:tad]	[inrʉ:tadə]	‘frame’
[prʉ:ta]	[prʉ:tat]	[prʉ:tad]	[prʉ:tadə]	‘bargain’
[sprʉ:ta]	[sprʉ:tat]	[sprʉ:tad]	[sprʉ:tadə]	‘spray’
[trʉ:ta]	[trʉ:tat]	[trʉ:tad]	[trʉ:tadə]	‘pout’
[tʉ:ta]	[tʉ:tat]	[tʉ:tad]	[tʉ:tadə]	‘toot’

8.9 Appendix 9: $C_0V(D)$ first conjugation words featuring vowels other than [ɑ] or [ʉ] as listed in *SAOL*

C_0ɛː

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[trɛːa]	[trɛːat]	[trɛːad]	[trɛːadə]	'perch on a tree'
[stɛːa]	[stɛːat]	[stɛːad]	[stɛːadə]	'call a dog'
[lɛːa]	[lɛːat]	[lɛːad]	[lɛːadə]	'give shelter for wind'
[relɛːa]	[relɛːat]	[relɛːad]	[relɛːadə]	'relay'
[knɛːa]	[knɛːat]	[knɛːad]	[knɛːadə]	'to kneel'

C_0yː

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[ɧyːa]	[ɧyːat]	[ɧyːad]	[ɧyːadə]	'to be covered by clouds'
[blyːa]	[blyːat]	[blyːad]	[blyːadə]	'add lead to s.t.'
[förnyːa]	[förnyːat]	[förnyːad]	[förnyːadə]	'renew'
[kryːa]	[kryːat]	[kryːad]	[kryːadə]	'recover'
[pryːa]	[pryːat]	[pryːad]	[pryːadə]	'get vocational experience'
[tyːa]	[tyːat]	[tyːad]	[tyːadə]	'manage'

C_0eː

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[fileːa]	[fileːat]	[fileːad]	[fileːadə]	‘fillet’
[ɧeleːa]	[ɧeleːat]	[ɧeleːad]	[ɧeleːadə]	‘make jelly’

C_0oː

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[ɧoːa]	[ɧoːat]	[ɧoːad]	[ɧoːadə]	‘work at docks’
[bloːa]	[bloːat]	[bloːad]	[bloːadə]	‘color blue’
[haloːa]	[haloːat]	[haloːad]	[haloːadə]	‘work as female anchor’
[förroːa]	[förroːat]	[förroːad]	[förroːadə]	‘make raw’
[toːa]	[toːat]	[toːad]	[toːadə]	‘walk on tiptoes’

C_0uː

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[huːa]	[huːat]	[huːad]	[huːadə]	‘yell *ho*’
[çuːa]	[çuːat]	[çuːad]	[çuːadə]	‘yell *tjo*’
[ruːa]	[ruːat]	[ruːad]	[ruːadə]	‘amuse’
[bruːa]	[bruːat]	[bruːad]	[bruːadə]	‘build bridges’

C_0iː

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[kliːa]	[kliːat]	[kliːad]	[kliːadə]	‘itch’
[niːa]	[niːat]	[niːad]	[niːadə]	‘say *ni*’
[befriːa]	[befriːat]	[befriːad]	[befriːadə]	‘set free’
[kniːa]	[kniːat]	[kniːad]	[kniːadə]	‘pull grass’
[siːa]	[siːat]	[siːad]	[siːadə]	‘prophesy’

C_0øː

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[køːa]	[køːat]	n/a[91]	[køːadə]	‘wait in line’
[sløːa]	[sløːat]	n/a	[sløːadə]	‘be lazy’
[snøːa]	[snøːat]	[snøːad]	[snøːadə]	‘snow’
[spøːa]	[spøːat]	[spøːad]	[spøːadə]	‘beat’
[brøːa]	[brøːat]	[brøːad]	[brøːadə]	‘strew crumbs’
[tøːa]	[tøːat]	[tøːad]	[tøːadə]	‘thaw’

C_0ɛːd

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[hɛːda]	[hɛːdat]	[hɛːdad]	[hɛːdadə]	‘blaspheme’
[stɛːda]	[stɛːdat]	[stɛːdad]	[stɛːdadə]	‘clean up’

[91] The word is intransitive, so there is no participle.

C_0yːd --

C_0eːd

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[ɧeːda]	[ɧeːdat]	[ɧeːdad]	[ɧeːdadə]	‘pick with spoon’
[uːfreːda]	[uːfreːdat]	[uːfreːdad]	[uːfreːdadə]	‘molest’

C_0oːd

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[boːda]	[boːdat]	[boːdad]	[boːdadə]	‘bode’
[skoːda]	[skoːdat]	[skoːdad]	[skoːdadə]	‘behold’
[noːda]	[noːdat]	[noːdad]	[noːdadə]	‘strike a tip’

C_0uːd

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[luːda]	[luːdat]	[luːdad]	[luːdadə]	‘measure’
[bluːda]	[bluːdat]	[bluːdad]	[bluːdadə]	‘put blood on’
[anmuːda]	[anmuːdat]	[anmuːdad]	[anmuːdadə]	‘request’
[førmuːda]	[førmuːdat]	[førmuːdad]	[førmuːdadə]	‘assume’

C_0iːd

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[biːda]	[biːdat]	[biːdad]	[biːdadə]	‘wait’

C_0øːd

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[døːda]	[døːdat]	[døːdad]	[døːdadə]	‘kill’
[fløːda]	[fløːdat]	[fløːdad]	[fløːdadə]	‘flow’
[brøːda]	[brøːdat]	[brøːdad]	[brøːdadə]	‘strew crumbs’

C_0ɛːt

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[flɛːta]	[flɛːtat]	[flɛːtad]	[flɛːtadə]	‘plait’
[slɛːta]	[slɛːtat]	[slɛːtad]	[slɛːtadə]	‘flatten’
[nɛːta]	[nɛːtat]	[nɛːtad]	[nɛːtadə]	‘to net’
[rɛːta]	[rɛːtat]	[rɛːtad]	[rɛːtadə]	‘straighten’
[frɛːta]	[frɛːtat]	[frɛːtad]	[frɛːtadə]	‘corrode’
[tɛːta]	[tɛːtat]	[tɛːtad]	[tɛːtadə]	‘seal’

C_0yːt --

C_0eːt

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[arbeːta]	[arbeːtat]	[arbeːtad]	[arbeːtadə]	‘work’
[beːta]	[beːtat]	[beːtad]	[beːtadə]	‘graze’
[kleːta]	[kleːtat]	[kleːtad]	[kleːtadə]	‘smear’
[leːta]	[leːtat]	[leːtad]	[leːtadə]	‘seek’
[meːta]	[meːtat]	[meːtad]	[meːtadə]	‘fish with rod’
[smeːta]	[smeːtat]	[smeːtad]	[smeːtadə]	‘smear’

[gne:ta]	[gne:tat]	[gne:tad]	[gne:tadə]	‘write small’
[pe:ta]	[pe:tat]	[pe:tad]	[pe:tadə]	‘poke’
[re:ta]	[re:tat]	[re:tad]	[re:tadə]	‘tease’
[spe:ta]	[spe:tat]	[spe:tad]	[spe:tadə]	‘stick up’
[spre:ta]	[spre:tat]	[spre:tad]	[spre:tadə]	‘stand out’
[førtre:ta]	[førtre:tat]	[førtre:tad]	[førtre:tadə]	‘make bitter’
[stre:ta]	[stre:tat]	[stre:tad]	[stre:tadə]	‘work hard’

C_0o:t

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bo:ta]	[bo:tat]	[bo:tad]	[bo:tadə]	‘travel by boat’
[no:ta]	[no:tat]	[no:tad]	[no:tadə]	‘apply a seam’
[plo:ta]	[plo:tat]	[plo:tad]	[plo:tadə]	‘photograph’
[po:ta]	[po:tat]	[po:tad]	[po:tadə]	‘poke about’
[so:ta]	[so:tat]	[so:tad]	[so:tadə]	‘stack hay’
[sto:ta]	[sto:tat]	[sto:tad]	[sto:tadə]	‘show off’

C_0u:t

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bu:ta]	[bu:tat]	[bu:tad]	[bu:tadə]	‘heal’
[fu:ta]	[fu:tat]	[fu:tad]	[fu:tadə]	‘photograph’
[kanu:ta]	[kanu:tat]	[kanu:tad]	[kanu:tadə]	‘travel by canoe’
[mu:ta]	[mu:tat]	[mu:tad]	[mu:tadə]	‘bar the way’
[ru:ta]	[ru:tat]	[ru:tad]	[ru:tadə]	‘dig’
[skru:ta]	[skru:tat]	[skru:tad]	[skru:tadə]	‘throw away’

[su:ta]	[su:tat]	[su:tad]	[su:tadə]	‘sweep chimney’
[tu:ta]	[tu:tat]	[tu:tad]	[tu:tadə]	‘patch’

C_0i:t

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[anli:ta]	[anli:tat]	[anli:tad]	[anli:tadə]	‘employ’
[fli:ta]	[fli:tat]	[fli:tad]	[fli:tadə]	‘to work hard’
[li:ta]	[li:tat]	[li:tad]	[li:tadə]	‘depend on’
[ni:ta]	[ni:tat]	[ni:tad]	[ni:tadə]	‘apply brakes’
[pli:ta]	[pli:tat]	[pli:tad]	[pli:tadə]	‘write with difficulty’
[ri:ta]	[ri:tat]	[ri:tad]	[ri:tadə]	‘draw’

C_0ø:t

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bø:ta]	[bø:tat]	[bø:tad]	[bø:tadə]	‘fine’
[gløːta]	[gløːtat]	[gløːtad]	[gløːtadə]	‘dig’
[grø:ta]	[grø:tat]	[grø:tad]	[grø:tadə]	‘make a mess’
[sprø:ta]	[sprø:tat]	[sprø:tad]	[sprø:tadə]	‘support’
[sø:ta]	[sø:tat]	[sø:tad]	[sø:tadə]	‘sweeten’

8.10 Appendix 10: $C_0V(D)$ fourth conjugation (ablaut) words featuring [ɑ] or [ʉ] as listed in Holmes & Hinchliffe 2003 and *SAG* 1999.

C_0ɑː

INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[drɑː]	[drɑːgɪt]	[drɑːgən]	[druːg]	'pull'
[tɑː]	[tɑːgɪt]	[tɑːgən]	[tuːg]	'take'

C_0ʉː --

C_0ɑːd --

C_0ʉːd

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bjʉːd]	[bjʉːdɪt]	[bjʉːdən]	[bjøːd]	'invite'
[jʉːd]	[jʉːdɪt]	n/a	[jøːd]	'make a sound'
[ɧʉːd]	[ɧʉːdɪt]	[ɧʉːdən]	[ɧøːd]	'boil'

C_0ɑːt --

C_0ʉːt

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[jʉːt]	[jʉːtɪt]	[jʉːtən]	[jøːt]	‘cast iron’
[jʉːt]	[jʉːtɪt]	n/a	[jøːt]	‘die’
[njʉːt]	[njʉːtɪt]	[njʉːtən]	[njøːt]	‘enjoy’
[ɧʉːt]	[ɧʉːtɪt]	[ɧʉːtən]	[ɧøːt]	‘shoot’
[slʉːt]	[slʉːtɪt]	[slʉːtən]	[sløːt]	‘close’
[çʉːt]	[çʉːtɪt]	n/a	[çøːt]	‘shriek’

8.11 Appendix 11: C_0V(D) fourth conjugation (ablaut) words featuring vowels other than [ɑ] or [ʉ]

as listed in Holmes & Hinchliffe 2003 and *SAG* 1999.

C_0ɛː --

C_0yː --

C_0eː --

C_0oː

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[sloː]	[slɑːgɪt]	[slɑːgən]	[sluːg]	‘hit’

C_0uː --

C_0iː --

C_0øː --

C_0ɛːd --

C_0yːd --

C_0eːd --

C_0oːd --

C_0uːd --

C_0iːd

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[gliːd]	[gliːdɪt]	n/a	[gleːd]	‘glide’
[kviːd]	[kviːdɪt]	n/a	[kveːd]	‘whine’
[liːd]	[liːdɪt]	n/a	[leːd]	‘suffer’
[riːd]	[riːdɪt]	[riːdən]	[reːd]	‘ride’
[skriːd]	[skriːdɪt]	[skriːdən]	[skreːd]	‘advance’
[striːd]	[striːdɪt]	n/a	[streːd]	‘fight’
[sviːd]	[sviːdɪt]	n/a	[sveːd]	‘sting’
[vriːd]	[vriːdɪt]	[vriːdən]	[vreːd]	‘twist’

C_0øːd --

C_0ɛːt

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[ɛːt]	[ɛːtɪt]	[ɛːtən]	[oːt]	‘eat’

C_0yːt

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bryːt]	[bruːtɪt]	[bruːtən]	[brøːt]	‘break’
[flyːt]	[fluːtɪt]	[fluːtən]	[fløːt]	‘float’
[knyːt]	[knuːtɪt]	[knuːtən]	[knøːt]	‘tie’
[ryːt]	[ruːtɪt]	[ruːtən]	[røːt]	‘roar’

[skryːt]	[skruːtɪt]	n/a	[skrøːt]	‘brag’
[snyːt]	[snuːtɪt]	[snuːtən]	[snøːt]	‘blow one’s nose’
[tryːt]	[truːtɪt]	n/a	[trøːt]	‘end’

C_0eːt --

C_0oːt

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[groːt]	[groːtɪt]	n/a	[grɛːt]	‘cry’
[loːt]	[loːtɪt]	n/a	[lɛːt]	‘allow’

C_0uːt --

C_0iːt

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[biːt]	[biːtɪt]	[biːtən]	[beːt]	‘bite’
[sliːt]	[sliːtɪt]	[sliːtən]	[sleːt]	‘wear out’
[smiːt]	[smiːtɪt]	n/a	[smeːt]	‘escape’
[ɧiːt]	[ɧiːtɪt]	[ɧiːtən]	[ɧeːt]	‘shit’

C_0øːt --

8.12 Appendix 12: Stimuli for experiment on perceptibility of [n]

Nasal-nasal stimuli

[sɛ̞mː]	[sɛ̞mː]	
[fʏmn]	[fʏmn]	
[sʏmː]	[sʏmn]	(order randomized)

[spʏmː]	[spʏmn]	(order randomized)
[kl̥øːm]	[kl̥øːm]	
[brɛ̝mn]	[brɛ̝mn]	
[krɛ̝mː]	[krɛ̝mn]	(order randomized)
[rø̞mː]	[rø̞mn]	(order randomized)
[plamː]	[plamː]	
[pø̞mn]	[pø̞mn]	
[stramː]	[stramn]	(order randomized)
[klamː]	[klamn]	(order randomized)
[traŋː]	[traŋː]	
[pʏŋn]	[pʏŋn]	
[ɧʏŋː]	[ɧʏŋn]	(order randomized)
[tʏŋː]	[tʏŋn]	(order randomized)
[søŋː]	[søŋː]	
[daŋn]	[daŋn]	
[ɧaŋː]	[ɧaŋn]	(order randomized)
[støŋː]	[støŋn]	(order randomized)
[spɛ̝ŋː]	[spɛ̝ŋː]	
[pløŋn]	[pløŋn]	
[lɛ̝ŋː]	[lɛ̝ŋn]	(order randomized)

[praŋː]	[praŋn]	(order randomized)

All of the items in the lateral condition featured a coda [l]:

Lateral-nasal stimuli: vowel /ɑ/

[çɑːl]	[çɑːl]	
[frɑːln]	[frɑːln]	
[rɑːl]	[rɑːln]	(order randomized)
[krɑːl]	[krɑːln]	(order randomized)
[bjɑːl]	[bjɑːl]	
[brɑːln]	[brɑːln]	
[drɑːl]	[drɑːln]	(order randomized)
[fjɑːl]	[fjɑːln]	(order randomized)
[tvɑːl]	[tvɑːl]	
[vrɑːln]	[vrɑːln]	
[pɑːl]	[pɑːln]	(order randomized)
[spɑːl]	[spɑːln]	(order randomized)

Lateral-nasal stimuli: version with [oːl(n)]

[droːl]	[droːl]	
[sproːln]	[sproːln]	
[dvoːl]	[dvoːln]	(order randomized)
[doːl]	[doːln]	(order randomized)

[ɦoːl]	[ɦoːl]	
[spoːln]	[spoːln]	
[joːl]	[joːln]	(order randomized)
[kvoːl]	[kvoːln]	(order randomized)

[voːl]	[voːl]	
[froːln]	[froːln]	
[groːl]	[groːln]	(order randomized)
[bjoːl]	[bjoːln]	(order randomized)

Lateral-nasal stimuli: version with [ɔl(n)]

[drɔlː]	[drɔlː]	
[sprɔln]	[sprɔln]	
[dvɔlː]	[dvɔln]	(order randomized)
[dɔlː]	[dɔln]	(order randomized)

[ɦɔlː]	[ɦɔlː]	
[spɔln]	[spɔln]	
[jɔlː]	[jɔln]	(order randomized)
[kvɔlː]	[kvɔln]	(order randomized)

[brɔlː]	[brɔlː]	
[frɔln]	[frɔln]	
[grɔlː]	[grɔln]	(order randomized)

[bjɔlː]	[bjɔln]	(order randomized)

All of the items in the vocalic condition featured long vowels.

Vowel-nasal stimuli

[gɑː]	[gɑː]	
[triːn]	[triːn]	
[stiː]	[stiːn]	(order randomized)
[vriː]	[vriːn]	(order randomized)
[slɑː]	[slɑː]	
[bjɑːn]	[bjɑːn]	
[tjeː]	[tjeːn]	(order randomized)
[pleː]	[pleːn]	(order randomized)
[tjyː]	[tjyː]	
[klyːn]	[klyːn]	
[stɛː]	[stɛːn]	(order randomized)
[plyː]	[plyːn]	(order randomized)
[fløː]	[fløː]	
[gløːn]	[gløːn]	
[prɛː]	[prɛːn]	(order randomized)
[bjoː]	[bjoːn]	(order randomized)
[pluː]	[pluː]	

[rɛːn]	[rɛːn]	
[pjoː]	[pjoːn]	(order randomized)
[sluː]	[sluːn]	(order randomized)
[bluː]	[bluː]	
[pøːn]	[pøːn]	
[blʉː]	[blʉːn]	(order randomized)
[kroː]	[kroːn]	(order randomized)

8.13 Appendix 13: Text on clouds (for lateral-nasal condition of experiment on perceptibility of nasals)

Ett moln är en samling i atmosfären av vattendroppar eller iskristaller som är tillräckligt små för att deras fallhastighet ska vara mycket liten. Dropparna bildas vid ungefär 100% relativ fuktighet genom att vattenånga kondenserar på små partiklar, kondensationskärnor, och sedan växer genom fortsatt kondensation och sammanslagning av droppar. De hålls svävande i molnet så länge deras fallhastighet är mindre än luftens rörelse uppåt; därefter faller dropparna genom molnundersidan som nederbörd. Även iskristaller bildas på små partiklar, s.k. iskärnor. Om molnet är tillräckligt kallt fryser molndropparna till iskristaller, men iskristaller kan även bildas direkt från vattenånga genom sublimation.

From http://www.ne.se/kort/moln

8.14 Appendix 14: Stimuli for repetition blindness triggered by [ən], [an], [ɔn]

[kɪkːɔn]	[kɪkːɔn]	
[kɔkːɔnən]	[kɔkːɔnən]	
[kɛ̞kːɔn]	[kɛ̞kːɔnən]	(order randomized)
[kakːɔn]	[kakːɔnən]	(order randomized)
[kɔkːan]	[kɔkːan]	
[kɛ̞kːanən]	[kɛ̞kːanən]	
[kakːan]	[kakːanən]	(order randomized)
[kɪkːan]	[kɪkːanən]	(order randomized)
[kakːən]	[kakːən]	
[kɔkːənən]	[kɔkːənən]	
[kɛ̞kːən]	[kɛ̞kːənən]	(order randomized)
[kɪkːən]	[kɪkːənən]	(order randomized)
[pɛ̞pːɔn]	[pɛ̞pːɔn]	
[papːɔnən]	[papːɔnən]	
[pɪpːɔn]	[pɪpːɔnən]	(order randomized)
[pɔpːɔn]	[pɔpːɔnən]	(order randomized)
[papːan]	[papːan][92]	
[pɪpːanən]	[pɪpːanən]	

[92] This item would be a real word if it were pronounced with pitch accent 2 (it means 'Dad'); but it was elicited with accent 1.

[pɔpːan]	[pɔpːanən]	(order randomized)
[pɛ̣pːan]	[pɛ̣pːanən]	(order randomized)
[pɪpːən]	[pɪpːən]	
[pɔpːənən]	[pɔpːənən]	
[pɛ̣pːən]	[pɛ̣pːənən]	(order randomized)
[papːən]	[papːənən]	(order randomized)
[tɔtːɔn]	[tɔtːɔn]	
[tɛ̣tːɔnən]	[tɛ̣tːɔnən]	
[tatːɔn]	[tatːɔnən]	(order randomized)
[tɪtːɔn]	[tɪtːɔnən]	(order randomized)
[tɛ̣tːan]	[tɛ̣tːan]	
[tatːanɛn]	[tatːanən]	
[tɪtːan]	[tɪtːanən]	(order randomized)
[tɔtːan]	[tɔtːanən]	(order randomized)
[tatːən]	[tatːən]	
[tɪtːənən]	[tɪtːənən]	
[tɔtːən]	[tɔtːənən]	(order randomized)
[tɛ̣tːən]	[tɛ̣tːənən]	(order randomized)

8.15 Appendix 15 : Stimuli for perceptibility of degemination

[tɔda]	[tɔda]	
[tɛ̝dːa]	[tɛ̝dːa]	
[tɪda]	[tɪdːa]	(order randomized)
[tø̝da]	[tø̝dːa]	(order randomized)
[tɪgda]	[tɪgda]	
[tɔgdːa]	[tɔgdːa]	
[tø̝gda]	[tø̝gdːa]	(order randomized)
[tɛ̝gda]	[tɛ̝gdːa]	(order randomized)
[tø̝nda]	[tø̝nda]	
[tɪndːa]	[tɪndːa]	
[tɛ̝nda]	[tɛ̝ndːa]	(order randomized)
[tɔnda]	[tɔndːa]	(order randomized)
[tɛ̝jda]	[tɛ̝jda]	
[tɔjdːa]	[tɔjdːa]	
[tø̝jda]	[tø̝jdːa]	(order randomized)
[tajda]	[tajdːa]	(order randomized)
[tø̝lda]	[tø̝lda]	
[tɛ̝ldːa]	[tɛ̝ldːa]	
[tɔlda]	[tɔldːa]	(order randomized)
[talda]	[taldːa]	(order randomized)

[tɪta]	[tɪta]	
[tɔtːa]	[tɔtːa]	
[tø̞ta]	[tø̞tːa]	(order randomized)
[tɛ̝ta]	[tɛ̝tːa]	(order randomized)
[tø̞kta]	[tø̞kta]	
[tɪktːa]	[tɪktːa]	
[tɛ̝kta]	[tɛ̝ktːa]	(order randomized)
[tɔkta]	[tɔktːa]	(order randomized)
[tɛ̝nta]	[tɛ̝nta]	
[tø̞ntːa]	[tø̞ntːa]	
[tɔnta]	[tɔntːa]	(order randomized)
[tɪnta]	[tɪntːa]	(order randomized)
[tɛ̝jta]	[tɛ̝jta]	
[tajtːa]	[tajtːa]	
[tø̞jta]	[tø̞jtːa]	(order randomized)
[tɔjta]	[tɔjtːa]	(order randomized)
[tɔlta]	[tɔlta]	
[tɛ̝ltːa]	[tɛ̝ltːa]	

[tǫlta]	[tǫlt:a]	(order randomized)
[talta]	[talt:a]	(order randomized)

8.16 Appendix 16: Stimuli for perceptual distances between tense and lax vowels

[hi:t]	[hi:t]	
[hɪt:]	[hɪt:]	
[hi:t]	[hɪt:]	(order randomized)
[hi:t]	[hɪt:]	(order randomized)
[hy:t]	[hy:t]	
[hʏt:]	[hʏt:]	
[hy:t]	[hʏt:]	(order randomized)
[hy:t]	[hʏt:]	(order randomized)
[hʉ:t]	[hʉ:t]	
[hɵt:]	[hɵt:]	
[hʉ:t]	[hɵt:]	(order randomized)
[hʉ:t]	[hɵt:]	(order randomized)
[he:t]	[he:t]	
[hɛ̝t:]	[hɛ̝t:]	
[he:t]	[hɛ̝t:]	(order randomized)
[he:t]	[hɛ̝t:]	(order randomized)

[høːt]	[høːt]	
[hø̞tː]	[hø̞tː]	
[høːt]	[hø̞tː]	(order randomized)
[høːt]	[hø̞tː]	(order randomized)
[hɛːt]	[hɛːt]	
[hɛ̞tː]	[hɛ̞tː]	
[hɛːt]	[hɛ̞tː]	(order randomized)
[hɛːt]	[hɛ̞tː]	(order randomized)
[hɑːt]	[hɑːt]	
[hatː]	[hatː]	
[hɑːt]	[hatː]	(order randomized)
[hɑːt]	[hatː]	(order randomized)
[huːt]	[huːt]	
[hʊtː]	[hʊtː]	
[huːt]	[hʊtː]	(order randomized)
[huːt]	[hʊtː]	(order randomized)
[hoːt]	[hoːt]	
[hɔtː]	[hɔtː]	
[hoːt]	[hɔtː]	(order randomized)
[hoːt]	[hɔtː]	(order randomized)

9 References

Albright, Adam. (2003). A quantitative study of Spanish paradigm gaps. In Garding, G. & M. Tsujimura (Eds.), *WCCFL 23 Proceedings.* Somerville, MA: Cascadilla Press.

Alderete, John. (2001). Dominance effects as transderivational anti-faithfulness. *Phonology 18*, 201-253.

Ali, L., T. Gallager, J. Goldstein & R. Daniloff. (1971). Perception of coarticulated nasality. *JASA, 49*, 538-40.

Allén, Sture et al. (1970-1980). *Nusvensk frekvensordbok baserad på tidningstext.* Stockholm: Almqvist & Wiksell.

Anttila, Arto. (2002). Variation and phonological theory. In Chambers, Jack , Peter Trudgill and Natalie Schilling-Estes (Eds.), *Handbook of language variation and change* (pp.206-243). Malden, MA and Oxford, UK, Blackwell.

Baayen, R. Harald, R. Piepenbrock & L. Gulikers. (1995). The CELEX Lexical Database (Release 2) [CD-ROM]. Philadelphia, Penn: Linguistics Data Consortium, University of Pennsylvania [Distributor].

Bakovic, Eric. (2005). Antigemination, assimilation and the determination of identity. *Phonology, 22*, 279-315.

Bavelier, Daphne. (1994). Repetition blindness between visually different items: The case of pictures and words. *Cognition, 51*, 199-236.

Bavelier, Daphne & Mary Potter. (1992). Visual and phonological codes in repetition blindness. *Journal of experimental psychology: Human perception and performance, 18*, 134-147.

Beddor, P. (1993). The perception of nasal vowels, In: Huffman, M.K., & R.A. Krakow (Eds.), *Phonetics and Phonology: Nasals, nasalization, and the velum* (pp. 171-196). New York: Academic Press.

Benua, Laura. (1997). *Transderivational identity: Phonological relations between words.* Doctoral dissertation, University of Massachusetts Amherst.

Bergsveinsson, Sveinn. (1941). *Grundfragen der isländischen Satzphonetik.* Kopenhagen & Berlin.

Blevins, Juliet. (2004). *Evolutionary Phonology.* Cambridge: Cambridge University Press.

Boersma, Paul. (1998). *Functional phonology: Formalizing the interactions between articulatory and perceptual drives.* Doctoral dissertation, University of Amsterdam.

Boersma, Paul & David Weenink. (2008). Praat: doing phonetics by computer. [Computer program]. Retrieved December 1, 2008, from `http://www.praat.org/`

Börjars, K.E. (1988). *Stress, segment duration, and syllable structure.* Ms., University of Leiden.

Broadbent, D.E. (1967). Word-frequency effect and response bias. *Psychological review* 74:1-15.

Buchanan, Charles. (2007). *Deriving asymmetry in Swedish and Icelandic inflexional paradigms.* Masters thesis, Universitetet i Tromsø.

Bybee, Joan. (2001). *Phonology and language use.* Cambridge: Cambridge University Press.

Cederschiöld, G. (1912). Hemvant och främmande i nominalböjningen. *Språk och stil, 12*, 133-150.

Chlumsky, N. (1928). Česká kvantita, melodie e přízvuk. (Rozpravy české Akademie věd a uměni 3, 65.) Praha 1928. (With a summary in French.)

Coetzee, Andries. (2009). Phonological variation and lexical frequency. In Anisa Schardl, Martin Walkow, & Muhammad Abdurrahman (Eds.), *NELS* 38. *Volume 1.* (pp. 189-202). Amherst: GLSA.

Crosswhite, Katherine. (1999). Intra-Paradigmatic homophony avoidance in two dialects of Slavic. *UCLA Working Papers in Linguistics 1*, 48-67.

De Boer, B. (2001). *The origins of vowel systems.* Oxford: Oxford University Press.

Durand, Marguerite. (1936). Durée phonétique et durée phonologique, *Proceedings of 3rd congress phonet.* 261-5.

Einarsson, Stéfan. (1927). *Beiträge zur Phonetik der isländischen Sprache.* Unknown publisher: Oslo.

Elert, Claes-Christian. (1966). *Allmän och svensk fonetik.* Stockholm: Almqvist & Wiksell.

Elert, Claes-Christian. (1970). *Ljud och ord i svenskan.* Stockholm: Almqvist & Wiksell.

Elert, Claes-Christian. (1979). *Allmän och svensk fonetik.* Almqvist & Wiksell: Stockholm.

Elert, Claes-Christian. (1981). *Ljud och ord i svenskan 2.* Stockholm: Almqvist & Wiksell.

Elert, Claes-Christian. (1997). Inledning. In Hedelin, Per (Ed.) *Norstedts svenska uttalslexikon.* Stockholm: Norstedts.

Eliasson, Stig. (1972). Unstable vowels in Swedish: syncope, epenthesis, or both? In Firchow, E.S. Kaaren Grimstad, Nils Hasselmo & Wayne A. O'Neil (Eds.) *Studies for Einar Haugen* (pp. 174-188). The Hague: Mouton.

Eliasson, Stig. (1975). On the issue of of directionality. In Dahlstedt, Karl-Hampus (Ed.), *The Nordic languages and modern linguistics* (pp. 421-445). Stockholm: Almqvist & Wiksell.

Eliasson, Stig. (1978). Swedish quantity revisited. In Gårding, E., G. Bruce & R. Bannert (Eds.) *Nordic prosody: Papers from a symposium.* Travaux de l'Institut de Linguistique de Lund 13. Lund: Department of Linguistics, Lund University.

Eliasson, Stig. (1980). Expressiv geminering hos svenska hypkorismer och ellipsord. *Nysvenska studier, 80*, 341-361.

Eliasson, Stig. (1985). Stress alternations and vowel length: New evidence for a underlying nine-vowel system in Swedish. *Nordic Journal of Linguistics, 8,* 101-129.

Eliasson, Stig & Nancy la Pelle. (1973). Generativa regler för svenskans kvantitet. *Arkiv för nordisk filologi, 88*, 133-148.

Epstein, R. & Nancy Kanwisher. (1999). Repetition blindness for locations. *Journal of experimental psychology: Human perception and performance, 25*, 1855-1866.

Fant, Gunnar. (1973). *Speech sounds and features*. Cambridge: MIT Press.

Fintoft, K. (1961). The duration of some Norwegian speech sounds, *Phonetica 7*, 19-39.

Fisher, R. A. (1922). On the interpretation of χ^2 from contingency tables, and the calculation of P. *Journal of the Royal Statistical Society*, *85*, 87–94.

Fleischhacker, Heidi. (2005). *Similarity in Phonology: Evidence from reduplication and loan adaptation.* Doctoral dissertation, UCLA.

Flemming, Edward. (2004). Contrast and perceptual distinctiveness. In Bruce Hayes Robert Kirchner & Donca Steriade (eds.) *Phonetically based Phonology* (pp. 232-276). Cambridge: Cambridge University Press.

Flemming, Edward. (2007). Modeling listeners. Commentary for Laboratory Phonology 10. Ms.

Forster, K.I.F. & S.M. Chambers. (1973). Lexical access and naming time. *Journal of verbal learning and verbal behaviour, 12*, 627-35.

Ganong, William F. III (1980). Phonetic categorization in auditory word perception. *Journal of experimental psychology: Human perception and performance, 6*, 110-125.

Gellerstam, Martin. (1998). *Svenska Akademiens ordlista över svenska språket.* Stockholm: Norstedts.

Gnanadesikan, Amalia (1997). *Phonology with ternary scales.* Doctoral dissertation. University of Massachusetts, Amherst.

Gordon, Matthew. (1997). Syllable weight and the phonetics/phonology interface. *Berkeley Linguistics Society, 23*, 111-122.

Gove, Philip Babcock. (1993). *Webster's Third New International Dictionary of the English Language: Unabridged.* Springfield, MA: Mirriam-Webster.

Hadding-Koch, Kerstin & A.S. Abramson. (1964). Duration versus spectrum in Swedish vowels: some perceptual experiments. *Studia Linguistica, 18*, 94-107.

Hammond, Michael. (1999). Lexical frequency and rhythm. In Michael Darnell, Edith A. Moravcsik, Michael Noonan, Frederick J. Newmeyer & Kathleen M. Wheatley (Eds.) *Functionalism and formalism in linguistics 1.* John Benjamins: Amsterdam.

Hawkins S. & K. N. Stevens. (1985). Acoustic and perceptual correlates of the nonnasal-nasal distinction for vowels. *JASA, 33*, 589-96.

Hayes, Bruce. (1999). Phonetically Driven Phonology: The role of Optimality Theory and inductive grounding. In Michael Darnell, Edith Moravscik, Michael Noonan,

Frederick Newmeyer, and Kathleen Wheatly, (Eds.) *Functionalism and Formalism in Linguistics*, *Volume I: General Papers* (pp. 243-285). John Benjamins: Amsterdam.

Hedelin, Per (Ed.). (1997). *Norstedts svenska uttalslexikon.* Stockholm: Norstedts.

Hellberg, Staffan. (1974). *Graphonomic rules in phonology.* Doctoral dissertation, University of Göteborg.

Holmes, Philip & Ian Hinchliffe. (2003). *Swedish: a comprehensive grammar.* London, New York: Routledge.

Hooper, Joan. (1978). Constraints on schwa-deletion in English. In Jacek Fisiak (Ed.) *Recent developments in historical phonology* (pp.183-208). The Hague: Mouton. .

Hume E. & Keith Johnson (eds.) (2001). *The role of speech perception in Phonology.* New York: Academic Press.

Inkelas, Sharon. (1998). The theoretical status of morphologically conditioned phonology: A case study of dominance effects. In Geert Booij and Jaap van Marle (Eds.) *Yearbook of Morphology 1997* (pp.121-155). Dordrecht: Kluwer.

Iverson, Gregory. (1981). Rules, constraints, and paradigmatic lacunae. *Glossa, 15*,136-144.

Kanwisher, Nancy. (1987). Repetition blindness: Type recognition without token individuation. *Cognition, 27*,117-143.

Kanwisher, Nancy, J. Driver & N. L. Machado. (1995). Spatial repetition blindness is modulated by selective attention to color or shape. *Cognitive psychology, 29*, 202-227.

Kanwisher, Nancy, C. Yin & N. Wojciulik. (1999). Repetition blindness for pictures: Evidence for the rapid computation of abstract visual descriptions. In Coltheart, Veronika (Ed.) *Fleeting memories* (pp. 119-150). Cambridge, MA: MIT Press.

Kawahara, Shigeto. (2006). A faithfulness ranking projected from a perceptibility scale: The case of [+voice] in Japanese. *Language, 82*, 536-574.

Kawasaki, H. (1982). *An acoustic basis of universal constraints on sound sequences.* Doctoral dissertation, University of California, Berkeley.

Kiparsky, Paul. (1982). *Explanation in Phonology.* Dordrecht: Foris.

Kloster Jensen, M. (1968). Long consonant after short vowel. *Proceedings of the fourth intenational congress of the phonetic sciences.* The Hague: Mouton.

Kurisu, Kazatuka. (2001). *The phonology of morpheme realization.* Doctoral dissertation, UCSC.

Kuronen, Mikko. (2000). *Vokaluttalets akustik i sverigesvenska, finlandssvenska och finska.* Studia philologica Jyväskyläensia 49. Doctoral dissertation, University of Jyväskylä.

Ladefoged, Peter. (2000). *A Course in Phonetics.* Boston: Thomson Wadsworth.

Langacker, Ronald W. (1968). *Language and its structure: some fundamental linguistic concepts.* New York: Harcourt, Brace & World.

Lehiste, Ilse. (1970). *Suprasegmentals.* Cambridge, MA: MIT Press.

Linell, Per. (1972). Remarks on Swedish morphology. *RUUL* 1, Uppsala universitet.

Linell, Per. (1973). On the Phonology of the Swedish vowel system. *Studia Linguistica, 27,* 1-52.

Linell Per. (1978). Vowel length and consonant length in Swedish word level phonology, In Gårding, E., G. Bruce and R. Bannert (Eds.), *Nordic Prosody: Papers from a Symposium (*pp. 123-136). Department of Linguistics, Lund University.

Linell Per, Bengt Svensson & Sven Öhman. (1971). *Ljudstruktur.* Gleerups: Lund.

Löfstedt, Ingvar. (1992). Swedish Segment Length and Structure Preservation, *Studia Linguistica, 46*, 93-127.

Macmillan, N.A. & Creelman, C.D. (2005). *Detection Theory: a user's guide.* Mahwah, N.J.: Lawrence Erlbaum Associates.

Malécot, A. (1956). Acoustic cues for nasal consonants: An experimental study involving a tape-splicing technique. *Language, 34*, 370-80.

Malmberg, Bertil. (1971). *Svensk fonetik*. Lund: Gleerups.

McCarthy, John J. & Matthew Wolfe. (2005). Less than zero: correspondence and the null output. Ms.

McCarthy, John & Alan Prince. (1995). Faithfulness and reduplicative identity. In Jill Beckman, Suzanne Urbanczyk, & Laura Walsh Dickey (Eds.), *University of Massuchusetts Occasional Papers in Linguistics* 18: Papers in Optimality Theory.

Metz, Clara. (1914). *Ein experimentell-phonetischer Beitrag zur Untersuchung der italienischen Konsonantgemination.* Glückstadt.

Modéer, Ivar. (1965). *Svenska personnamn. Handbok för universitetsbruk och självstudier.* Anthroponymica suecana 5. Studentlitteratur: Lund.

Navarro Tomás T. (1916). Cantidad de las vocales accentuadas. *Revista de filologia Española, 3*, 387-408.

Noréen, Adolf. (1903-24). *Vårt språk.* Lund: Gleerups.

Ohala, J.J. (1992). Alternatives to the sonority hierarchy for explaining segmental constraints. In *Papers from the parasession on the syllable.* Chicago: Chicago Linguistic Society, 319-38.

Orgun, C. Orhan. (1996). *Sign-based morphology and phonology with special attention to Optimality Theory.* Doctoral dissertation, UCB.

Paliwal, KK, W.A. Ainsworth & D. Lindsay. (1983). A study of two-formant models for vowel identification. *Speech Communication 2*, 295-303.

Park, J. & Nancy Kanwisher. (1994). Determinants of repetition blindness. *Journal of experimental psychology: Human perception and performance 18*, 849-880.

Pertsova, Katya. (2005). How Lexical Conservatism can lead to paradigm gaps. In Heinz, Martin & Pertsova (Eds.) *UCLA Working papers in Linguistics 11*: *Papers in Phonology 6.*

Peterson, G.E. & Ilse Lehiste. (1960). Duration of syllable nuclei in English. *JASA, 32*, 693-703.

Pinker, Steven. (1984). *Language learnability and language development.* Cambridge, MA: Harvard University Press.

Prince, Alan & Paul Smolensky. (1993/2004). *Optimality Theory: constraint interaction in generative grammar.* Oxford: Blackwell.

Raffelsiefen, Renate. (2002). Quantity and syllable weight in Swedish. Ms.

Raphael , Lawrence. (2007). Acoustic cues to the perception of segmental phonemes. In David Pesoni & Robert Remez (Eds.) *Handbook of speech perception* (pp. 182-206). Oxford: Blackwell. .

Riad, Tomas. (1992). *Structures in Germanic prosody. A diachronic study with special reference to the Nordic languages.* Doctoral dissertation, Stockholm University.

Riad, Tomas. (2002). Svensk smeknamnsfonologi. *Studia anthroponymica scandinavica, 20,* 51-98.

Riad, Tomas. (2003). Bestämdhetssuffixens form och tvåstavigheten. In Lars-Olof Delsing, Cecilia Falk, Gunlög Josefsson & Halldór Sigurdsson (Eds.), *Grammatik i focus: Festskrift till Christer Platzack 18 november 2003* (pp. 145–152). Walin & Dalholm: Lund.

Rice, Curt. (2005). Optimal gaps in optimal paradigms. *Catalan Journal of Linguistics 4*, 155-170.

Rose, Sharon. (1997). *Theoretical issues in comparative Ethio-Semitic phonology and morphology.* Doctoral dissertation, McGill University, Montreal.

Rose, Sharon. (2005). Lengthening effects: non-contrastive duration, moras, or sonority? Talk presented at UCLA Linguistics colloquium.

Russian National Corpus. Natsional'nyi Korpus Russkogo Iazyka. URL `www.ruscorpora.ru`

Saffran, J.R., E.L. Newport & R.N Aslin. (1996). Word segmentation: the role of distributional cues. *Journal of Memory and Language, 35*, 606–621.

Samek-Lodovici, Vieri. (1993). Morphological gemination. Paper presented at ROW-1, Rutgers University. October 1993.

Schmid, Kristine Beata. (1987). *Non-linear approaches to Swedish word prosody.* Doctoral dissertation, Brown University.

Schwartz, Jean-Luc, Louis-Jean Boë, Nathalie Vallée & Christian Abry. (1997). Major trends in vowel system inventories. *Journal of Phonetics, 25,* 223-253.

Sebastián Gallés, Núria, M. Antonia Martí Antonin, Manuel Francisco Carreiras Valiña, Fernando Cuetos Vega. (2000). *LEXESP: Léxico informatizado del español.* (CDROM) Edicions Universitat de Barcelona.

Sigurd, Bengt. (1965). *Phonotactic structures in Swedish.* Uniskol: Lund.

Stemberger, Joseph. (1981). Morphological haplology. *Language, 57*, 791-817.

Steriade, Donca. (1994). Lexical conservatism, in *Linguistics in the morning calm, Selected papers from SICOL 1997* (pp. 157-179), Linguistic Society of Korea: Hanshin Publishing House.

Steriade, Donca. (2001). The phonology of perceptibility effects: the P-map and its consequences for constraint organization. *Ms.* University of California, Los Angeles.

Tegnér, Esaias. (1930). Om elliptiska ord. *Ur språkens värld III.* Albert Bonniers Förlag: Stockholm.

Teleman, Ulf. (1969). Böjningssuffixens form in nusvenskan. *Arkiv för nordisk filologi, 84*, 163-298.

Teleman, Ulf, Staffan Hellberg, Erik Andersson, Lisa Christensen, Helena Hansson, Lena Lötmarker & Bo-A. Wendt. (1999). *Svenska Akademiens grammatik 2: Ord.* Norstedts Ordbok/Svenska Akademien: Stockholm.

Thorén, Bosse. (2008). *The priority of temporal aspects in L2-Swedish Prosody: Studies in perception and production.* Doctoral dissertation, Stockholm University.

Thun, Nils. (1992). Bengt och Bengan. Två sätt att bilda smek- och öknamn. In Lars-Erik Edlund & Gunnar Persson (Eds.), *Language—the Time Machine. Papers in Honour of Bengt Odenstedt on the Occasion of his Sixtieth Birthday, July 2, 1992.* Umeå Studies in the Humanities 107: Umeå.

Vallée, Nathalie. (1994). *Systèmes vocaliques: De la typologie aux predictions.* Doctoral dissertation, Université de Grenoble.

Walker, Rachel. (2000). Nasal reduplication in Mbe affixation. *Phonology, 17*, 65-115.

Walter, MaryAnn. (2007). *Repetition avoidance in human language.* Doctoral dissertation. MIT.

Whaley, C.P. (1978). Word-nonword classification time. *Journal of verbal learning and verbal behaviour, 17*, 143-54.

Wilson, Colin. (2006). Learning Phonology with substantive bias: An experimental and

computational study of velar palatalization. *Cognitive Science, 30*, 945-982.

Witting, Claes. (1977). Studies in Swedish Generative Phonology. *Studia Philologiae Scandinavicae Upsaliensia* 11. Uppsala.

Wright, Richard. (2004). A review of perceptual cues and cue robustness. In Bruce Hayes, Robert Kirchner & Donca Steriade (Eds.), *Phonetically Based Phonology* (pp. 34-57). Cambridge: Cambridge University Press.

Zhang, Jie. (2004). The role of contrast-specific and language-specific phonetics in contour tone distribution. In Bruce Hayes, Robert Kirchner, and Donca Steriade (Eds.), *Phonetically based phonology.* Cambridge University Press, Cambridge, UK.

Zhang, Jie. (2007). Constraint weighting and constraint domination: A formal comparison. *Phonology, 24*, 433-459.

Zuraw, Kie. (2007). The role of phonetic knowledge in phonological patterning: Corpus and survey evidence from Tagalog. *Language, 83*, 277-316.

Zwicky, Arnold. (1972). A note on a phonological hierarchy in English. In Robert Stockwell & Ronald Macaulay (Eds.), *Linguistic change and generative theory* (pp. 275-301). Bloomington: Indiana University Press.