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

4 Vowel-vowel correspondence and *MAP

4.1 Overview

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

It will be argued that 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 enter 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.

4.2.1 Templatic gemination

The first source of intraparadigmatic vowel-length alternation involves nicknames. Nicknames have a C_0VCːə template. 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/. 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][26]. The derived post-alveolars [ɖ, ɳ, ɭ] are generally short. Following the general phonotactic patterns, a stressed vowel preceding the voiced postalveolar 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 postalveolar 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 postalveolar [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 postalveolar is generally short. The following is an example:

---

[26] 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/ → [hør + d] '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 phonemic sequence is provided, not the coalesced item.

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

In some exceptional words, the voiceless postalveolars [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 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.

4.3 Alternating vowels

4.3.1 Introduction

Having reviewed the fundamental mechanisms that result in I-O and O-O correspondence between short and long vowels in Swedish, consider each case in some detail. We will first review two cases where correspondence holds between all of the vowel pairs of Swedish: these cases are based on Eliasson's seminal studies on the Swedish phoneme inventory.

4.3.2 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). 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.

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]gɵst	[a]gːə
	Δ (ʉ , ɵ)	kn[ʉː]t	kn[ɵ]tːə
		h[ʉː]bert	h[ɵ]bːə
	Δ (ɛ , ɛ̞)	p[ɛː]r	p[ɛ̞]rːa
	Δ (y , ʏ)	st[yː]rbjørn	st[ʏ]bːə
	Δ (e , ɛ̞)	st[eː]fan	st[ɛ̞]fːə
		h[eː]dvig	h[ɛ̞]dːə
	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 , ø̞)	j[øː]ran	j[ø̞]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, Svensson & Öhman 1978 claim that the long vowels are all [+tense], and all of the short vowels are [-tense]. Elert 1997, in his preface to Hedelin 1997, 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	ɛ̞
y	ʏ
e	ɛ̞
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[ɛ̞ː]r

*st[y]bːə	*st[ʏː]rbjørn
*st[e]fːə	*st[ɛ̝ː]fan
*h[e]dːə	*h[ɛ̝ː]dvig
*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.

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

Having established correspondence between long and short vowels in the preceding section, I will 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 (ɛ̝ , ɛ)	--	--	
Δ (ʏ , y)	meton[ʏ]ˈm + iː	metoˈn[yː]m + isk	'metonymy'
Δ (ɛ̝ , e)	ˈisra[ɛ̝]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,ø̝)	--	--	

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[27]:

---

[27] 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. 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 [-TENSE]	* SHORT V [+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[ɛ̞ː]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 introduce the phenomenon of post-alveolar coalescence. 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 (Prince & Smolensky 1993/2004) formalism 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 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.[28] 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

> in practically all languages in which consonant duration has been measured, unvoiced consonants are longer than voiced consonants. This is reported to be

[28] Recall that unstressed vowels are always short.

> 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_{μ} / [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_{μ} / [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 militating against non-coalesced r+coronal clusters.

(203) *r[+cor]

[r] may not be followed by a coronal segment

We noted that tenseness and length are correlated. A biconditional statement of this correlation captures this generalization, and rules out inappropriate correlations:

(204) [+LONG] $\leftrightarrow$ [+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'		$\sigma_{\mu\mu} \leftrightarrow$ [+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'	σ$_{μμ}$ ↔ [+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					*

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) σ$_{μμ}$ ↔ [+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:

(209)

STANDARD FORM	*	GLOSS
[ˈga$_L$rd]	*[ˈgɑː$_T$ɖ]	‘guard’
[ˈkɵ$_L$rd]	*[ˈkʉː$_T$ɖ]	‘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 surface with a long tense vowel followed by a coalesced post-alveolar. The arrow ‘ > ’ marks the attested form; the bomb-symbol ‘💣’ marks the incorrectly predicted output.

(210)

/ga$_L$rd/ ‘guard’		$\sigma_{\mu\mu}$ ↔ [+stress]	*C$_\mu$ / [ɖ ɳ ɭ]	[+LONG]↔ [+TENSE]	*r[+cor]	I IDENT [tense]
a.	gɑ$_T$ːɖ̥ː	*	*			*
b.	ga$_L$ ɖ̥ː		*			
c.	ga$_L$ːɖ̥			*		
d. >	ga$_L$rd				*	
e. 💣	gɑ$_T$ːɖ̥					*

The same problem arises for the word for ‘Kurd’:

(211)

		/kɵ$_{L}$rd/ 'Kurd'	$\sigma_{\mu\mu}$ ↔ [+stress]	*C$_{\mu}$ / [ɖ ɳ ɭ]	[+LONG]↔ [+TENSE]	*r[+cor]	IDENT [tense]
a.		kʉ$_{T}$ːɖ̢ː	*	*			*
b.		kɵ$_{L}$ɖ̢ː		*			
c.		kɵ$_{L}$ːɖ			*		
d.	>	kɵ$_{L}$rd				*	
e.	💣	kʉ$_{T}$ːɖ					*

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$_{\mu}$ / [ɖ ɳ ɭ]	[+LONG]↔ [+TENSE]	IDENT [tense]	*r[+cor]
a.		gɑː$_{T}$ɖ ː	*	*		*	
b.		ga$_{L}$ɖ̢ː		*			
c.		gaː$_{L}$ɖ			*		
d.	>	ga$_{L}$rd					*
e.		gɑː$_{T}$ɖ				*	

(213)

/kɵ$_L$rd/ 'Kurd'		$\sigma_{\mu\mu}$ ↔ [+stress]	*C$_\mu$ / [ɖ ɳ ɭ]	[+LONG]↔ [+TENSE]	IDENT [tense]	*r[+cor]
a.	kʉ$_T$:ɖ:	*	*		*	
b.	kɵ$_L$ɖ:		*			
c.	kɵ$_L$:ɖ			*		
d. >	kɵ$_L$rd					*
e.	kʉ$_T$: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 put it differently, why they are marked with the diacritic. Also, the diacritic account fails to capture a generalization: only words featuring the vowels [a, ɵ] block coalescence of voiced post-alveolars. In most dialects, coalescence is blocked in the following words:

(214)

VOWEL	STANDARD FORM	*	GLOSS
[a]	[ˈga$_L$rd]	*[ˈgɑː$_T$ɖ]	'guard'
[a]	[bilˈja$_L$rd]	*[bilˈjɑː$_T$ɖ]	'billiards'
[a]	[bʊləˈva$_L$rd]	*[bʊləlˈvɑː$_T$ɖ]	'boulevard'
[ɵ]	[ˈɵ$_L$rdʉ]	*[ˈʉː$_T$ɖʉ]	'Urdu'
[ɵ]	[apˈsɵ$_L$rd]	*[apˈsʉː$_T$ɖ]	'absurd'
[ɵ]	[ˈkɵ$_L$rd]	*[ˈkʉː$_T$ɖ]	'Kurd'

Blocked coalescence is unattested with other vowels. The following chart shows words which feature coalesced coronals after the other vowels, modulo one accidental gap:

(215)

V	UR	SR	*	GLOSS
ɛ	/jɛrna/	[ˈjɛːɳa]	*[ˈjɛ̞rna]	‘with pleasure’
y	--	--	--	--
e	/herde/	[ˈheːɖe]	*[ˈhe̞rde]	‘shepherd’
o	/porl/	[poːɭ]	*[pɔrl]	‘murmur’
u	/hurn/	[huːɳ]	*[hʊrn]	‘horn’
i	/hird/	[hiːɖ]	*[hɪrd]	‘housecarl’
ø	/børda/	[ˈbøːɖa]	*[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*, a critical 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's introduction to Hedelin 1997:17)[29], 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.[30]

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.

---

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

[30] 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 a ([ɑː] vs. [a]) and ʉ ([ʉː] vs. [ɵ])).[31]

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].[32]

Lehiste (1970) reviews experimental work of Hadding-Koch and Abramson (1964), who establish that the cue for distinguishing short [ɵ] and long [ʉː] was primarily quality, not duration. The opposite held true for the pairs [ɛ ɛ̩] and [ø ø̩]; for these vowels, duration was the main cue:

> Listening tests showed that length was the main cue for the pairs [vɛːg] / [vɛ̩gː] and [støːta] / [stø̩tːa]*;* however, for [fʉːl] / [fɵlː],[33] which contains vowels differing considerably in phonetic quality, the experimental findings assigned little or no perceptual importance to the relative duration. [...] Hadding-Koch and Abramson speculate that...cue value shifted…from length to quality in this

---

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

pair and as a result the constraint upon speakers to maintain a clear durational difference lessened.

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 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.

(217)

	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
ɛ̣$_{L}$	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
$ø̞_L$	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.

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

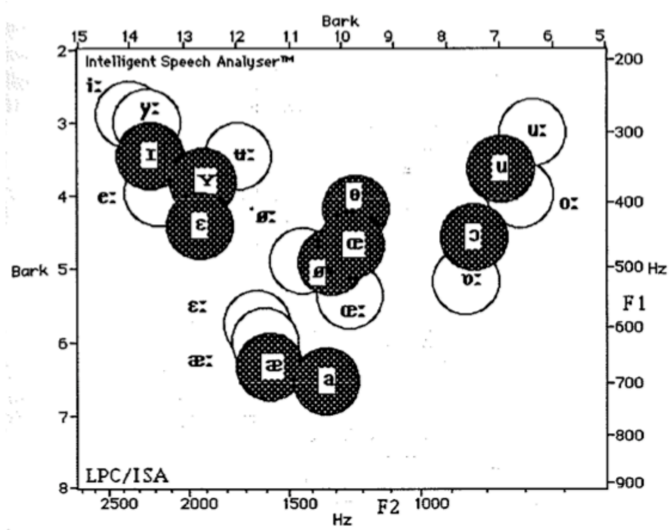
In this equation, D1 = 164.9 and D2 = 33.3. By transforming the formant values into Bark, and weighting F2′ at 0.3, as is standard (Vallée 1994; Schwartz, Boë, Vallée and Abry 1997; De Boer 2001), one obtains the following scale of perceptual distances between long tense vowels and short lax vowels. The vowel pairs are listed in order of decreasing perceptual distance.[34]

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

(219)		Δ {ɑ$_{T}$,a$_{L}$}	1.77
	>	Δ {ʉ$_{T}$,ɵ$_{L}$}	1.37
	>	Δ {ɛ$_{T}$,ɛ̞$_{L}$}	1.28
	>	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 can be seen graphically on the following chart from Kuronen (2000:119):

(220)



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.

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

(221) ***MAP S_1S_2 ($^AX^B$, $^CY^D$)** (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:

(222) **Distance-to-ranking projection** (Zuraw p.c.)[35]

If	$\Delta(^AX^B, {}^CY^D)$	>	$\Delta(^{A'}X'^{B'}, {}^{C'}Y'^{D'})$
then	*MAP S_1S_2 ($^AX^B$, $^CY^D$)	≫	*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′.[36]

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

(223)

	LAX-TO-TENSE		TENSE-TO-LAX
	*MAP (a_L, $ɑ_T$)		*MAP ($ɑ_T$, a_L)
≫	*MAP ($ɵ_L$, $ʉ_T$)	≫	*MAP ($ʉ_T$, $ɵ_L$)
≫	*MAP ($ɛ̣_L$, $ɛ_T$)	≫	*MAP ($ɛ_T$, $ɛ̣_L$)
≫	*MAP ($ʏ_L$, y_T)	≫	*MAP (y_T , $ʏ_L$)
≫	*MAP ($ɛ_L$, e_T)	≫	*MAP (e_T , $ɛ_L$)
≫	*MAP ($ɔ_L$, o_T)	≫	*MAP (o_T , $ɔ_L$)

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

≫	*MAP ($ʊ_L$, u_T)	≫	*MAP (u_T, $ʊ_L$)
≫	*MAP ($ɪ_L$, i_T)	≫	*MAP (i_T, $ɪ_L$)
≫	*MAP ($ø_Ł$, $ø_T$)	≫	*MAP ($ø_T$, $ø_L$)

By interleaving *r[+cor] in the first ranking in (223), the following scale is obtained:

(224) *MAP (a_L, $ɑ_T$)

≫ *MAP ($ɵ_L$, $ʉ_T$)

≫ *r[+cor] ← interleaved.

≫ *MAP ($ɛ̣_L$, $ɛ_T$)

≫ *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 ($ø_Ł$, $ø_T$)

Now consider the tableaux for 'guard', to see how the correct outputs are generated:

(225)

/ga$_L$rd/ 'guard'	$\sigma_{\mu\mu}$ ↔ [+stress]	*C_μ / [ɖ ɳ ɭ]	[+LONG] ↔ [+TENSE]	*MAP (a$_L$ ɑ$_T$)	*MAP (ɵ$_L$ ʉ$_T$)	*r[+cor]	*MAP (ø̞$_L$ ø$_T$)
a. gɑː$_T$ɖ̤ː	*			*			
b. ga$_L$ɖ̤ː		*					
c. gaː$_L$ɖ			*				
d. > ga$_L$rd						*	
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.

(226)

	/$\text{bø}_{L}\text{rd}$/ ‘lineage, descent’	$\sigma_{\mu\mu}$ ↔ [+stress]	*C_{μ} / [ɖ ɳ ɭ]	[+LONG]↔ [+TENSE]	*MAP (a_{L} $ɑ_{T}$)	*MAP ($ɵ_{L}$ $ʉ_{T}$)	*r[+cor]	*MAP ($ø_{L}$ $ø_{T}$)
a.	bø_{T}ːɖː	*						*
b.	bø_{L}ɖː		*					
c.	bø_{L}ːɖ			*				
d.	$\text{bø}_{L}\text{rd}$						*	
e. >	bø_{T}ːɖ							*

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. I assume that the vowel is marked as tense in UR, i.e., /$\text{bɑ}_{T}\text{rd}$/, so there is no violation of *MAP in this output.

(227)

	/bɑ$_T$rd/ 'bard'	σ$_{\mu\mu}$ ↔ [+stress]	*C$_\mu$ / [ɖ ɳ ɭ]	[+LONG]↔ [+TENSE]	*MAP (ɑ$_T$ a$_L$)	*r[+cor]
a.	bɑː$_T$ɖ ː	*				
b.	ba$_L$ɖː		*		*	
c.	baː$_L$ɖ			*	*	
d.	ba$_L$rd				*	*
e. >	bɑː$_T$ɖ					

4.5 Blocked laxing with voiceless post-alveolars

4.5.1 Data

Just as the mapping from [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:

(228)

UR	SR	*	GLOSS
/fars/	[faʂː]	*[fɑːʂ]	'farce'
/fors/	[fɔʂː]	*[foːʂ]	'rapids'
/børs/	[bøʂː]	*[bøːʂ]	'stock exchange'
/kørt/	[kɵʈː]	*[kʉːʈ]	'Kurt, a name'
/myrten/	[ˈmʏʈːən]	*[ˈmyːʈən]	'myrtle'

/jɛrta/ [ˈjɛ̝ʈːa] *[ˈjɛːʈa] ‘heart’

/lurt/ [lʊʈː] *[luːʈ] ‘filth’

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

(229) *C-μ / [ʂ̜ 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:

(230)

/fɔ$_L$rs/ ‘rapids’	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔ [+TENSE]	*r[+cor]	*C-μ / [ʂ̜ ʈ]	*MAP (o$_T$ ɔ$_L$)
a. fo$_T$ːʂ̜ː	*				
b. fo$_T$ʂ̜ː		*			
c. fɔ$_L$rs			*		
d. fo$_T$ːʂ̜				*	
e. > fɔ$_L$ʂ̜ː					

If, on the other hand, the vowel is tense in UR, we must assume that *C$_{-\mu}$/[ʂ̜ ʈ] ≫ *MAP (ɔ$_L$, o$_T$), to ensure that the unfaithful mapping of the vowel serves as the optimal candidate.

(231)

/fo$_T$rs/ 'rapids'	$\sigma_{\mu\mu} \leftrightarrow$ [+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					*

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$_{-\mu}$/ [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:

(232)

*CORRESP.	UR	SR	*	GLOSS
*ɑ → a	/lɑrs/	[ˈlɑːʂ]	*[ˈlaʂː]	'a name'
*ɑ → a	/ɑrt/	[ˈɑːʈ]	*[ˈaʈː]	'kind, sort'
*ɑ → a	/smɑrt/	[ˈsmɑːʈ]	*[ˈsmaʈː]	'smart'
*ɑ → a	/fɑrt/	[ˈfɑːʈ]	*[ˈfaʈː]	'speed'
*ɑ → a	/ɑrta/	[ˈɑːʈa]	*[ˈaʈːa]	'to shape'
*ɑ → a	/kɑrta/	[ˈkɑːʈa]	*[ˈkaʈːa]	'map'

Recall that we established above that *C$_{-\mu}$/ [ʂ ʈ] ≫ *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 ʈ] ≫ *MAP (a$_L$, ɑ$_T$); but this generates the wrong output:

(233)

	/lɑ$_T$rs/ 'Lars'	σ$_{\mu\mu}$ ↔ [+stress]	[+LONG]↔ [+TENSE]	*r[+cor]	*C-μ / [ʂ ʈ]	*MAP (ɑ$_T$ a$_L$)
a.	lɑ$_T$ːʂː	*				
b.	lɑ$_T$ʂː		*			
c.	la$_L$rs			*		*
d.	> lɑ$_T$ːʂ				*	
e.	💣 la$_L$ʂː					*

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]. There are no exceptional forms with the rime [ʉːʂ] or [ʉːʈ]. I will assume that this is an accident, to maximize parallelism with exceptional blocked coalescence, discussed in the preceding chapter.

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:

(234) = (223) *MAP (ɑ$_T$, a$_L$)

≫ *MAP (ʉ$_T$, ɵ$_L$)

≫ *MAP (ɛ$_T$, ɛ̯$_L$)

≫ *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$_{-μ}$/ [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:

(235) *MAP (ɑ$_T$, a$_L$)

≫ *MAP (ʉ$_T$, ɵ$_L$)

≫ *C$_{-μ}$/ [ʂ ʈ] ← interleaved.

≫ *MAP (ɛ$_T$, ɛ̯$_L$) and all other vowel pairs

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

(236)

		/lɑ$_T$rs/ 'Lars', a name	$σ_{μμ}$↔ [+stress]	[+LONG]↔ [+TENSE]	*r[+cor]	*MAP (ɑ$_T$ a$_L$)	*C-μ / [ʂ ʈ]	*MAP (o$_T$ ɔ$_L$)
a.		lɑ$_T$ːʂː	*					
b.		lɑ$_T$ʂː		*				
c.		la$_L$rs			*	*		
d.	>	lɑ$_T$ːʂ					*	
e.		la$_L$ʂː				*		

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

(237)

		/fo$_T$rs/ 'rapids'	$σ_{μμ}$↔ [+stress]	[+LONG]↔ [+TENSE]	*r[+cor]	*MAP (ɑ$_T$ a$_L$)	*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.		fo$_L$ʂː						*

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.

(238)

/fa$_L$rs/ ‘farce’	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔ [+TENSE]	*r[+cor]	*MAP ($ɑ_T$ 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. 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:

(239)

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 adjectives of the third conjugation; i.e., verbs of the form C$_{0}$V, grouped by vowel:[37]

(240)

CORRESP.	#ATTESTED	STEM	SUP	GLOSS
ɑ$_{T}$ → a$_{L}$	0 (PREDICTED)	--	--	--
ʉ$_{T}$ → ɵ$_{L}$	0 (PREDICTED)	--	--	--
ɛ$_{T}$ → ɛ̣$_{L}$	3	kl[ɛː]	kl[ɛ̣]tː	‘clothe’
y$_{T}$ → ʏ$_{L}$	6	ˈbr[yː]	ˈbr[ʏ]tː	‘care’
e$_{T}$ → ɛ	5	ˈɧ[eː]	ˈɧ[ɛ̣]tː	‘occur’
o$_{T}$ → ɔ$_{L}$	10	ˈfl[oː]	ˈfl[ɔ]tː	‘flay’
u$_{T}$ → ʊ$_{L}$	11	ˈgn[uː]	ˈgn[ʊ]tː	‘rub’
i$_{T}$ → ɪ$_{L}$	0	--	--	--
ø$_{T}$ → ø$_{L}$	2	ˈstr[øː]	ˈstr[ø̣]tː	‘sprinkle’

The vowels [ɑ$_{T}$ a$_{L}$] and [ʉ$_{T}$ ɵ$_{L}$] are, as predicted, not represented.

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

4.6.2 Exceptional third conjugation: C_0V stems

There are also some exceptional verbs of the third conjugation of the form C_0V. These form the participle and preterite by ablaut, but the supine is still formed by means of a geminate suffix. Again, the vowels [$ɑ_T$, a_L] and [$ʉ_T$, $ɵ_L$] are not attested in this group.[38]

(241)

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

These gaps are not due to a lack of stems of the form $C_0ɑ$. $C_0ɑ$ stems are included among some of the most common words of the language; however, these are so-called fourth conjugation verbs, with irregular morphology and ablaut. Consider the supine, participle, and preterite forms of the verbs 'take' and 'pull':

[38] For a complete list, see appendix 2.

(242)	INFINITIVE	SUPINE	PARTICIPLE	PRETERITE	GLOSS
	[tɑː]	[tɑːgit]	[tɑːgən]	[tuːg]	‘take’
		*[tatː]	*[tadː]	*[tadːə]	
	[drɑː]	[drɑːgit]	[drɑːgən]	[druːg]	‘pull’
		*[dratː]	*[dradː]	*[dradːə]	

In no part of the paradigm does the correspondence [$ɑ_T$, a_L] take place.

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.

(243)	INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
	beˈt[$yː_T$]da	beˈt[$ʏ_L$]tː	beˈt[$ʏ_L$]dː	beˈt[$ʏ_L$]dːə	‘mean’
	ˈf[$øː_T$]da	ˈf[$ø̞_L$]tː	ˈf[$ø̞_L$]dː	ˈf[$ø̞_L$]dːə	‘give birth’

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

(244)	INF	SUPINE	PARTICIPLE	PRETERITE	GLOSS
	ˈm[$ɛː_T$]ta	ˈm[$ɛ̞_L$]tː	ˈm[$ɛ̞_L$]tː	ˈm[$ɛ̞_L$]tːə	‘measure’
	ˈb[$yː_T$]ta	ˈb[$ʏ_L$]tː	ˈb[$ʏ_L$]tː	ˈb[$ʏ_L$]tːə	‘exchange’
	ˈɧ[$øː_T$]ta	ˈɧ[$ø̞_L$]tː	ˈɧ[$ø̞_L$]tː	ˈɧ[$ø̞_L$]tːə	‘look after’

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 (‘second conjugation’) organized by vowel:[39]

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

(245)

CORRESP.	#ATTESTED	INFINITIVE	SUPINE	GLOSS
ɑ$_T$ → a$_L$	0 (PREDICTED)	--	--	--
ʉ$_T$ → ɵ$_L$	0 (PREDICTED)	--	--	--
ɛ$_T$ → ɛ̞$_L$	0	--	--	--
y$_T$ → ʏ$_L$	4	beˈt[yː]da	beˈt[ʏ]tː	‘meet’
e$_T$ → ɛ	0	--	--	--
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$_0$ɑd or C$_0$ʉd. Stems of the form C$_0$ɑd 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 suffixes dental consonant. Here is an example:

(246)

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$_0$ʉd are easily found, but these tend to be part of the the fourth conjugation, which forms the supine and participle with exceptional suffixation, and the preterite by means of ablaut.

(247)

STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
[bjʉːd]	[ˈbjʉːdit]	[ˈbjʉːden]	[ˈbjøːd]	‘invite’
	*[bjɵtː]	*[bjɵtː]	*[ˈbjɵdːə]	

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’):[40]

(248)

CORRESP.	#ATTESTED	STEM	SUPINE	GLOSS
$\text{ɑ}_T \rightarrow \text{a}_L$	0 (PREDICTED)	--	--	--
$\text{ʉ}_T \rightarrow \text{ɵ}_L$	0 (PREDICTED)	--	--	--
$\text{ɛ}_T \rightarrow \text{ɛ̞}_L$	1	ˈm[ɛː]t	ˈm[ɛ̞]tː	‘measure’
$\text{y}_T \rightarrow \text{ʏ}_L$	1	ˈb[yː]ta	ˈb[ʏ]tː	‘exchange’
$\text{e}_T \rightarrow \text{ɛ̞}_L$	0	--	--	--
$\text{o}_T \rightarrow \text{ɔ}_L$	0	--	--	--
$\text{u}_T \rightarrow \text{ʊ}_L$	0	--	--	--
$\text{i}_T \rightarrow \text{ɪ}_L$	0	--	--	--
$\text{ø}_T \rightarrow \text{ø̞}_L$	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.

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

(249)	STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
	[hɑːt]	[ˈhɑːtat]	[ˈhɑːtad]	[ˈhɑːtadə]	'hate'
		*[hatː]	*[hatː]	*[ˈhatːə]	
	[kʉːt]	[ˈkʉːtat]	[ˈkʉːtad]	[ˈkʉːtadə]	'run'
		*[kɵtː]	*[kɵtː]	*[ˈkɵtːə]	

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:

(250)	STEM	SUPINE	PARTICIPLE	PRETERITE	GLOSS
	[ˈjʉːta]	[ˈjʉːtit]	[ˈjʉːten]	[jøːt]	'cast metal'
		*[jɵtː]	*[jɵtː]	*[ˈjɵtːə]	

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

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.

(251)	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.[41]

[41] For a complete list, see Appendix 5. Lists are obtained from Holmes & Hinchliffe 1994.

(252)

CORRESP.	# ATTESTED	STEM	NEUTER	GLOSS
$ɑ_T$ → a_L	0 (PREDICTED)	--	--	--
$ʉ_T$ → $ɵ_L$	0 (PREDICTED)	--	--	--
$ɛ_T$ → $ɛ̞_L$	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:

(253)

*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.

(254)

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

The vowels [$ɑ_T$, a_L] and [$ʉ_T$, $ɵ_L$] are underrepresented in these paradigms. There is only one[42] 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:[43]

(255)

CORRESP.	# ATTESTED	STEM	NEUTER	GLOSS
$ɑ_T$ → a_L	1	gl[ɑː]d	gl[a]tː	'happy'
$ʉ_T$ → $ɵ_L$	0 (PREDICTED)	--	--	--
$ɛ_T$ → $ɛ̞_L$	0	--	--	--
y_T → $ʏ_L$	0	--	--	--
e_T → ɛ	1	br[eː]d	br[ɛ̞]tː	'broad'
ʹo_T → $ɔ_L$	0	--	--	--
u_T → $ʊ_L$	0	--	--	--
i_T → $ɪ_L$	3	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:[44]

(256)

CORRESP.	# ATTESTED	STEM	NEUTER	GLOSS
$ɑ_T$ → a_L	0 (PREDICTED)	--	--	--
$ʉ_T$ → $ɵ_L$	0 (PREDICTED)	--	--	--
$ɛ_T$ → $ɛ̞_L$	0	--	--	--
y_T → $ʏ_L$	0	--	--	--

[42] 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.
[43] For a complete list, see appendix 6.
[44] For a complete list, see appendix 7.

$e_T \rightarrow$ ɛ	2	h[eː]t	h[ɛ̞]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'
$ø_T \rightarrow$ $ø_L$	0	--	--	--

Note that this is not due to a lack of lexical items of the form C_0ɑt. The word for 'lazy' is [l$ɑ_T$ːt], and this is famously ineffable in the neuter (Cederschiöld 1912; cited in Raffelsiefen 2002). Where we would expect an output of the form [latː], there is instead a gap in the paradigm:

(257)

*CORRESP.	STEM	*	NEUTER	GLOSS
*$ɑ_T \rightarrow a_L$	[l$ɑ_T$ːt]	*[la_Ltː]	NULL PARSE	'lazy'

The difference between the words of the form C_0ɑt and words of the form C_0et, C_0ot, and C_0it is related *MAP constraints. 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; in particular, it is ranked higher than M-PARSE, the constraint that penalizes the NULL PARSE candidate '⊙'(Prince & Smolensky 1993/2004). So, for the word 'lazy, n.', the NULL PARSE candidate is the optimal candidate.

(258)

/$l\alpha_T t$ + tː/ 'lazy, n.' cf. SR [$l\alpha_T$ːt]		$\sigma_{\mu\mu} \leftrightarrow$ [+stress]	I-O IDENT (Long C)	[+LONG]$\leftrightarrow$ [+TENSE]	*MAP (α_T,a_L)	M-PARSE	*MAP (e_T,ε_L)
a.	$l\alpha_T$ːtː	*					
b.	$l\alpha_T$ːt		*				
c.	la_Ttː			*			
d.	$l\alpha_L$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 'hot',the candidate violating *MAP is optimal, and the NULL PARSE candidate is non-optimal.

(259)

/het + tː/ 'hot, n.' cf. SR [he_Tːt]		$\sigma_{\mu\mu} \Leftrightarrow$ [+stress]	I-O IDENT (Long C)	[+LONG]$\Leftrightarrow$ [+TENSE]	*MAP ($ɑ_T$,a_L)	M-PARSE	*MAP (e_T,$ɛ_L$)
a.	he_Tːtː	*					
b.	he_Tːt		*				
c.	he_Ttː			*			
d. >	$hɛ_L$tː						*
e.	⊙					*	

4.8 Statistical analysis of paradigm structure

4.8.1 Introduction

Fisher's Exact Test 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 adjectival and verbal 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. It may seem suggestive that there are no adjectives of the structure C_0ɑː in the regular adjectival paradigms, resulting in correspondence between [ɑ] and [a], but all other vowels are similarly underrepresented in the regular paradigms of the form C_0Vː, except [o, ɔ]: all other vowels have zero or only one word of the relevant form.

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.

(260)

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

I focused on words of the structure C_0Vː, C_0Vːd, and C_0Vːt. Other word types are irrelevant, since only these 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.

(261)

	verb	verb	verb	verb				
	3 conj.	ex3conj.	2conj	2conj	adj	adj	adj	
CORRESP.	CVː	ex.CVː	CVːd	CVːt	CVː	CVːd	CVːt	sum
ɑ$_T$ → a$_L$	0	0	0	0	0	1	0	1
ʉ$_T$ → ɵ$_L$	0	0	0	0	0	0	0	0
							total:	1

One regular adjective of the form C$_0$Vːd was found.

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

(262)

	verb	verb	verb	verb				
	3 conj.	ex3conj.	2conj	2conj.	adj	adj	adj	
CORRESP.	CVː	ex.CVː	CVːd	CVːt	CVː	CVːd	CVːt	sum
ε$_T$ → ε̣$_L$	3	0	0	1	0	0	0	4
y$_T$ → ʏ$_L$	6	0	4	1	1	0	0	12
e$_T$ → ε	5	4	0	0	0	1	2	12
o$_T$ → ɔ$_L$	10	3	0	0	3	0	1	17

$u_T \rightarrow ʊ_L$	11	0	0	0	0	0	0	11
$i_T \rightarrow ɪ_L$	0	0	0	0	1	3	1	5
$ø_T \rightarrow ø̞_L$	2	1	2	3	1	3	0	12
							total:	73

A total of 73 such adjectives and verbs were found.

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

(263)

	Dental gemination (tenseness-shifting)	Other verbal and adjectival paradigms (not tenseness-shifting)
[ɑ, a] and [ʉ, ɵ]	1	
other vowels	73	

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_0Vː, C_0Vːd, or C_0Vːt featuring [ɑ] or [ʉ] which are either unaffixed or ineffable in the neuter form. The neuter form would in the regular case feature an affixed [tː] and a short lax vowel.

(264) C_0Vː [brɑː] 'good' (unaffixed in neuter)

C_0Vːd [grɑːd] 'straight' (ineffable in neuter)

C_0Vːt [lɑːt] 'lazy' (ineffable in neuter)

In total, there are 3 such adjectives.

The following chart lists adjectives of the form C_0Vː, C_0Vːd, or C_0Vːt featuring other vowels which are either unaffixed or ineffable in the neuter form.

(265) C_0Vː [kryː] 'healthy' (ineffable in neuter)

C_0Vːd [vreːd] 'straight' (ineffable in neuter)

C_0Vːt --

In total, there are 2 such adjectives.

These values can be added to the matrix for Fisher's Exact Test:

(266)

	Dental gemination (tenseness-shifting)	Other verbal and adjectival paradigms (not tenseness-shifting)
[ɑ, a] and [ʉ, ɵ]	1	3 +
other vowels	73	2 +

The second case where verbal stems remain unchanged in paradigms are the 'first conjugation' verbs. 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':

(267)

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_0V:d and C_0V:t similarly maintain their vowel length throughout the paradigms, since the stressed syllable is always open, and the vowel is always long. Consider the verbs [blu:d-a] 'put blood on' and [ru:t-a] 'dig':

(268)

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_0V:, C_0V:d and C_0V:t, where the vowel is [ɑ] or [ʉ].[45] The examples are organized by stem type, and the number next to the stem type identifies the total number of examples for that type.

(269)

VOWEL	CV:	CV:d	CV:t	sum
ɑ:	0	6	8	14
ʉ:	4	3	13	20
			total	34

The total number of first conjugation verbs of the the form C_0V:, C_0V:d and C_0V:t 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].[46]

[45] For specific examples, see appendix 8.
[46] For specific examples, see appendix 9.

(270)

VOWEL	C_0V:	C_0V:d	C_0V:t	sum
ɛ:	5	2	6	13
y:	6	0	0	6
e:	2	2	13	17
o:	5	3	5	13
u:	4	4	9	17
i:	5	1	6	12
ø:	6	4	5	15
			total	93

The total number of first conjugation verbs of the form C_0V:, C_0V:d and C_0V:t featuring vowels other than [ɑ, ʉ] is 93. With the earlier observation, that the total number of first conjugation verbs of the form C_0V:, C_0V:d and C_0V:t featuring the vowels [ɑ, ʉ] is 34, we can continue to fill out the matrix:

(271)

	Dental gemination (tenseness-shifting)	Other verbal and adjectival paradigms (not tenseness-shifting)
[ɑ, a] and [ʉ, ɵ]	1	3 + 34 +
other vowels	73	2 + 93 +

The third case where shifts in tenseness are avoided are the ‘fourth conjugation’ pattern, where the stem is manipulated by ablaut. For example, the word ‘pull’ surfaces with tense [ɑ:] and tense [u:] in its paradigm; there is no [ɑ:]~[a] correspondence.

(272)

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].[47]

(273)

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].[48]

(274)

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	7	3	10
øː	0	0	0	0
			total	21

[47] For specific examples, see appendix 10.
[48] For specific examples, see appendix 11.

The total number of words of this type is 21. Noting that the corresponding number for the stems featuring the vowels [ɑ] and [ʉ] was 11, we can complete the matrix started above.

(275)

	Dental gemination (tenseness-shifting)	Other verbal and adjectival paradigms (not tenseness-shifting)
[ɑ, a] and [ʉ, ɵ]	1	3 + 34 + 11 = 48
other vowels	73	2 + 93 + 21 = 116

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 shifts 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 ($ɑ_T$, a_L) ≫ M-PARSE, as the following tableau shows:

(276)

/lɑ$_{T}$t + tː/ 'lazy, n.' cf. SR [lɑ$_{T}$ːt]	$\sigma_{\mu\mu} \leftrightarrow$ [+stress]	[+LONG]$\leftrightarrow$[+TENSE]	*MAP (ɑ$_{T}$,a$_{L}$)	M-PARSE
a. lɑ$_{T}$ ːtː	*			
b. lɑ$_{T}$tː		*		
c. la$_{L}$tː			*	
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 4.3.2 that this is not ineffable, but has an overt form with a short lax vowel—this is candidate (c) below.

(277)

CVCːə 'nickname for Jan' cf. SR [jɑ$_{T}$ːn]	$\sigma_{\mu\mu} \leftrightarrow$ [+stress]	[+LONG]$\leftrightarrow$[+TENSE]	*MAP (ɑ$_{T}$,a$_{L}$)	M-PARSE
a. jɑ$_{T}$ːnːə	*			
b. jɑ$_{T}$nːə		*		
c. > ja$_{L}$nːə			*	
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 4.3.3.

(278)

		/ˈalgebra +isk/ ‘algebraic’ cf. SR [ˈalgebra]	$\sigma_{\mu\mu} \leftrightarrow$ [+stress]	[+LONG]↔[+TENSE]	*MAP ($ɑ_T$,a_L)	M-PARSE
a.		algeˈbra$_L$isk	*			
b.		algeˈbraː$_L$isk		*		
c.	>	algeˈbrɑ$_T$ːisk			*	
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:

(279)

	CVCːə 'nickname for Jan' cf SR [jɑː$_T$n]	$\sigma_{\mu\mu} \leftrightarrow$ [+stress]	[+LONG]↔[+TENSE]	M-PARSE	*MAP (α_T,a_L)
a.	jɑ$_T$ːnːə	*			
b.	jɑ$_T$nːə		*		
c. >	ja$_L$nːə				*
d.	⊙			*	

(280)

	/ˈalgebra +isk/ 'algebraic' cf. SR [algebra]	$\sigma_{\mu\mu} \leftrightarrow$ [+stress]	[+LONG]↔[+TENSE]	M-PARSE	*MAP (α_T,a_L)
a.	algeˈbra$_L$isk	*			
b.	algeˈbra$_L$ːisk		*		
c. >	algeˈbrɑ$_T$ːisk				*
d.	⊙			*	

However, this of course generates the wrong output for neuter of 'lazy':

(281)

	/lɑ$_T$t + tː/ 'lazy, n.' cf. SR [lɑ$_T$ːt]	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG]↔[+TENSE]	M-PARSE	*MAP (ɑ$_T$,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:

(282)

/lɑ$_T$t + tː/ 'lazy, n.' cf. SR [lɑ$_T$ːt]	$\sigma_{\mu\mu} \leftrightarrow$ [+stress]	[+LONG]$\leftrightarrow$ [+TENSE]	*MAP (ɑ$_T$,a$_L$) /lɑt + tː/	M-PARSE	*MAP (ɑ$_T$,a$_L$) /jɑnːe/; /algebraisk/
a. lɑ$_T$ːtː	*				
b. lɑ$_T$tː		*			
c. la$_L$tː			*		
d. > ⊙				*	

(283)

CVCːə 'nickname for Jan' cf SR [jɑː$_T$n]	$\sigma_{\mu\mu} \leftrightarrow$ [+stress]	[+LONG]$\leftrightarrow$ [+TENSE]	*MAP (ɑ$_T$,a$_L$) /lɑt + tː/	M-PARSE	*MAP (ɑ$_T$,a$_L$) /jɑnːe/; /algebraisk/
a. jɑ$_T$ːnːə	*				
b. jɑ$_T$nːə		*			
c. > ja$_L$nːə					*
d. ⊙				*	

(284)

	/algebra + isk/ 'algebraic' cf. SR [ˈalgebra]	$\sigma_{\mu\mu} \leftrightarrow$ [+stress]	[+LONG] $\leftrightarrow$ [+TENSE]	*MAP ($ɑ_T$,a_L) /lɑt + tː/	M-PARSE	*MAP ($ɑ_T$,a_L) /jɑnːɛ/; /algebraisk/
a.	algeˈbra$_L$isk	*				
b.	algeˈbra$_L$ːisk		*			
c. >	algebrɑ$_T$ːisk					*
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, and nickname-formation and *–isk* affixation involve derivation. Inflectional forms require tighter O-O correspondence than non-inflectional forms; lexical processes can lead to more drastic stem alternations than postlexical processes, which are more conservative in nature.

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 ($ɑ_T$, a_L)/+INFL ≫ *MAP ($ɑ_T$, a_L)/-INFL. The unfaithful mapping from [$ɑ_T$] 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:

(285)

/l$ɑ_T$t + tː/ 'lazy, n.' cf. SR [l$ɑ_T$ːt]	$σ_{μμ}$ ↔ [+stress]	[+LONG]↔ [+TENSE]	*MAP ($ɑ_T$,a_L)/ +INFL	M-PARSE	*MAP ($ɑ_T$,a_L)/ -INFL
a. l$ɑ_T$ːtː	*				
b. l$ɑ_T$tː		*			
c. la_Ltː			*		
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 '⊙'.

(286)

	CVC:ə 'nickname for Jan' cf SR [jɑː$_T$n]	$\sigma_{\mu\mu} \Leftrightarrow$ [+stress]	[+LONG]⇔ [+TENSE]	*MAP (α_T,a_L)/ +INFL	M-PARSE	*MAP (α_T,a_L)/ -INFL
a.	jɑ$_T$:n:ə	*				
b.	jɑ$_T$n:ə		*			
c. >	ja$_L$n:ə					*
d.	⊙				*	

The same constraint generates the explicit output for *–isk* form generated with the stem [algebra], which is [algebrɑ:isk]. Again, this is a derivational form, and the relevant *MAP constraint is ranked lower than M-PARSE.

(287)

	/algebra+isk/ 'algebraic' cf. SR [ˈalgebra]	$\sigma_{\mu\mu} \Leftrightarrow$ [+stress]	[+LONG]⇔ [+TENSE]	*MAP (α_T,a_L)/ +INFL	M-PARSE	*MAP (α_T,a_L)/ -INFL
a.	algeˈbra$_L$isk	*				
b.	algeˈbra$_L$:isk		*			
c. >	algebrɑ$_T$:isk					*
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:

(288)	=(222)	If	$\Delta({}^{A}X^{B}, {}^{C}Y^{D})$	>	$\Delta({}^{A'}X'^{B'}, {}^{C'}Y'^{D'})$
		then	*MAP S_1S_2 $({}^{A}X^{B}, {}^{C}Y^{D})$	≫	*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).[49]

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.

[49] See section 1.8.

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. 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, and 'ambisyllabic', due to 'virtual' syllables. Recall, furthermore, that alternations in segment duration are regarded a phonetic effect, called 'stretching'. The lengthening of the neuter suffix is the result of the constraints MIN and AMBI [S-site]:

(289) MIN Morphologically marked words must be minimally bimoraic.
AMBI [S-site] Ambisyllabic consonants are stretching sites.

There is also a constraint on paradigmatic uniformity 'stretching', such that the same sound is long in all members of a given paradigm:

(290) 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].

(291)

	/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. >	⊙			*

Crucially, 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:

(292)

	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:

(293)

		/algebra + isk/ 'algebraic' cf. SR ['algebra]	O-O IDENT [BACK]	M-PARSE
a.	>	alge'brɑːisk	*	
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.

4.12 Local Summary

I have argued for the existence of the constraint family *MAP S_1S_2 ($^AX^B$,$^CY^D$)/ ± 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.

[hø:t]	[hø:t]	
[hø̞tː]	[hø̞tː]	
[hø:t]	[hø̞tː]	(order randomized)
[hø:t]	[hø̞tː]	(order randomized)
[hɛ:t]	[hɛ:t]	
[he̞tː]	[he̞tː]	
[hɛ:t]	[he̞tː]	(order randomized)
[hɛ:t]	[he̞tː]	(order randomized)
[hɑ:t]	[hɑ:t]	
[hatː]	[hatː]	
[hɑ:t]	[hatː]	(order randomized)
[hɑ:t]	[hatː]	(order randomized)
[hu:t]	[hu:t]	
[hʊtː]	[hʊtː]	
[hu:t]	[hʊtː]	(order randomized)
[hu:t]	[hʊtː]	(order randomized)
[ho:t]	[ho:t]	
[hɔtː]	[hɔtː]	
[ho:t]	[hɔtː]	(order randomized)
[ho:t]	[hɔtː]	(order randomized)

9 References

Albright, Adam. 2003. A quantitative study of Spanish paradigm gaps. In *WCCFL 23 Proceedings,* eds. G. Garding and M. Tsujimura. 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 Jack Chambers, Peter Trudgill and Natalie Schilling-Estes (eds.) *Handbook of language variation and change.* Malden, MA and Oxford, UK, Blackwell, pp.206-243.

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., Krakow, R.A. (eds), *Phonetics and Phonology: Nasals, Nasalization, and the Velum.*: Academic Press, pp. 171-196.

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.* Ph.D. disseration, University of Amsterdam.

Boersma, Paul & David Weenink. 2008. Praat: doing phonetics by computer. [Computer program]. Retrieved December 1, 2008, from `http://www.praat.org/`

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.)

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, *Proceed. 3rd congress phonet.* 261-5.

Einarsson, Stéfan. 1927. *Beiträge zur Phonetik der isländischen Sprache.* Oslo.

Elert, Claes-Christian. 1979. *Allmän och svensk fonetik.* Almqvist & Wiksell: Stockholm.

Eliasson, Stig. 1972. Unstable vowels in Swedish: syncope, epenthesis, or both? In E.S. Firchow et al. (eds.) *Studies for Einar Haugen.* The Hague: Mouton. 174-188.

Eliasson, Stig. 1975. On the issue of of directionality. In *The Nordic languages and modern linguistics/2*, ed. Karl-Hampus Dahlstedt, 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.

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*, 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. 1986. *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 et al. (eds.) *Functionalism and formalism in linguistics 1.* Amsterdam: Benjamins.

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, John Benjamins, Amsterdam, pp. 243-285.

Hedelin, Per. 1997. *Norstedts svenska uttalslexikon.* Stockholm: Norstedts.

Hellberg, Staffan. 1974. *Graphonomic rules in phonology.* PhD dissertation, University of Göteborg.

Holmes, Philip & Ian Hinchliffe. 1994. *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.* The Hague: Mouton. 183-208.

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.* Dordrecht, Kluwer, pp.121-155.

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 *Fleeting memories*, edited by Veronika Coltheart. Cambridge, MA: MIT Press. 119-150.

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.* PhD 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.* MIT Press: Cambridge, MA.

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,* Department of Linguistics, Lund University, 123-136.

Linell Per, Bengt Svensson & Sven Öhman. 1973. *Ljudstruktur.* Gleerups: Lund.

Löfstedt, Ingvar. 1992. Swedish Segment Length and Structure Preservation, *Studia Linguistica* 46, 193-127.

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.

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 experimantal 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 and Robert Remez (eds.) *Handbook of speech perception,* Oxford: Blackwell. 182-206.

Riad, Tomas. 1992. *Structures in Germanic prosody. A diachronic study with special reference to the Nordic languages.* Doctoral dissertation, Stockholm University.

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**, pp. 606–621

Samek-Lodovici, Vieri. 1993. Morphological gemination. Paper presented at ROW-1, Rutgers University. October 1993.

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.

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,* Linguistic Society of Korea, Hanshin Publishing House 157-179.

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.

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.* PhD 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*, Cambridge: Cambridge University Press, 34-57.

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.

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.* Bloomington: Indiana University Press. 275-301.