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
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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 C₀VCːə 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.
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 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>'bals[a]m</td>
<td>bal's[ɑː]m + isk</td>
<td>‘balsam/balsamic’</td>
<td></td>
</tr>
<tr>
<td>'talm[ø]d</td>
<td>tal'm[uː]d + sk</td>
<td>‘Talmud/Talmudic’</td>
<td></td>
</tr>
</tbody>
</table>

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]. 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)  

<table>
<thead>
<tr>
<th></th>
<th>UR</th>
<th>SR</th>
<th>*</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LONG VOWEL</td>
<td>/urd/</td>
<td>*[u]ɖ</td>
<td>*[u]rd</td>
<td>‘word’</td>
</tr>
</tbody>
</table>

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.
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:

(189)  

<table>
<thead>
<tr>
<th>UR</th>
<th>SR</th>
<th>*</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHORT VOWEL /kors/</td>
<td>k[ɔ]ʂ:</td>
<td>*k[ɔː]ʂ</td>
<td>‘cross’</td>
</tr>
</tbody>
</table>

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 C₀V stem, they close the syllable. The following chart provides some examples of the pattern:

(191)  

<table>
<thead>
<tr>
<th>VERB</th>
<th>ADJECTIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR GLOSS</td>
<td>SR GLOSS</td>
</tr>
<tr>
<td>'t[ʊ]</td>
<td>‘believe, inf’</td>
</tr>
<tr>
<td>'t[ʊ]t:</td>
<td>‘believe, sup’</td>
</tr>
<tr>
<td>'t[ʊ]d:</td>
<td>‘believe, part’</td>
</tr>
<tr>
<td>'t[ʊ]dː</td>
<td>‘believe, pret’</td>
</tr>
</tbody>
</table>

A stem with UR C₀V will surface as C₀V: in the unaffixed form; the vowel will be lengthened due to phonotactics. On the other hand, the affixed form will surface as C₀VCː, 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 /C₀VCːə/ template (Noréen 1903-24, Tegnér 1930, Modéer 1965, Eliasson 1980, Thun 1992). The first C₀ 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.
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: |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LONG V</td>
<td>SHORT V</td>
<td></td>
</tr>
<tr>
<td>[+TENSE]</td>
<td>[-TENSE]</td>
<td></td>
</tr>
<tr>
<td>α</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td>ʉ</td>
<td>θ</td>
<td></td>
</tr>
<tr>
<td>ε</td>
<td>ɛ</td>
<td></td>
</tr>
<tr>
<td>y</td>
<td>y</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>ɛ</td>
<td></td>
</tr>
<tr>
<td>o</td>
<td>ɔ</td>
<td></td>
</tr>
<tr>
<td>u</td>
<td>u</td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>ø</td>
<td>ø</td>
<td></td>
</tr>
</tbody>
</table>

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 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[+TENSE]</td>
<td>[-TENSE]</td>
<td></td>
</tr>
<tr>
<td>*h[ɑ]s:ɔ</td>
<td>*h[ɑː]ns</td>
<td></td>
</tr>
<tr>
<td>*[ɑ]ɡ:ɔ</td>
<td>*[ɑː]gɔst</td>
<td></td>
</tr>
<tr>
<td>*kn[ʉ]t:ɔ</td>
<td>*kn[œː]t</td>
<td></td>
</tr>
<tr>
<td>*h[ʉ]b:ɔ</td>
<td>*h[œː]bert</td>
<td></td>
</tr>
<tr>
<td>*p[ɛ]r:a</td>
<td>*p[ɛː]r</td>
<td></td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>(195)</th>
<th>UNAFFIXED STEM</th>
<th>STEM + isk</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHORT V</td>
<td>[ -TENSE ]</td>
<td>LONG V</td>
</tr>
<tr>
<td>Δ (a , a)</td>
<td>'algebr[a]</td>
<td>alge'br[ɑː] + isk</td>
</tr>
<tr>
<td></td>
<td>'bals[a]m</td>
<td>bal's[ɑː]m + isk</td>
</tr>
<tr>
<td>Δ (ø , u)</td>
<td>'talm[ø]d</td>
<td>tal'm[ʊː]d + isk</td>
</tr>
<tr>
<td>Δ (ɛ , e)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Δ (y , y)</td>
<td>meton[y]'m + i:</td>
<td>meto'n[yː]m + isk</td>
</tr>
<tr>
<td>Δ (ɛ , e)</td>
<td>'isra[ɛ]l</td>
<td>isra' [eː]l + isk</td>
</tr>
<tr>
<td>Δ (ɔ , o)</td>
<td>'eːr[ɔː]s</td>
<td>e'r[ɔː]t + isk</td>
</tr>
<tr>
<td>Δ (u , u)</td>
<td>o'raːt[u]r</td>
<td>ora't[uː]r + isk</td>
</tr>
<tr>
<td>Δ (i , i)</td>
<td>pul[i]t + isk</td>
<td>pu'l[iː]t + isk</td>
</tr>
<tr>
<td>Δ (oː,ø)</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

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 I am simplifying the facts slightly. The vowel [u] 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 [fam] ‘Satan’. Perhaps the phonotactically marginal quality of this word mirrors its taboo meaning.
(196)  *LONG V \hspace{1cm} * SHORT V  
\hspace{1cm} \begin{align*}
\text{-TENSE} & \quad \text{[ + TENSE]} \\
* \text{algebr[æːisk]} & \quad * \text{algebr[æ]} \\
* \text{bals[æːmisk]} & \quad * \text{bals[æ]m} \\
* \text{talm[øːdisk]} & \quad * \text{talm[ʊ]d} \\
* \text{meton[yːmisk]} & \quad * \text{meton[y]miː} \\
* \text{isra[ɛːlisk]} & \quad * \text{isra[e]l} \\
* \text{er[æːtisk]} & \quad * \text{er[o]s} \\
* \text{oræt[ʊːrisk]} & \quad * \text{oræt[ʊ]r} \\
* \text{pul[rːtisk]} & \quad * \text{pul[i]tik} 
\end{align*}

So, tenseness and length are correlated in the paradigms of \text{–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. The following examples illustrate this phonotactic:

(197)  | V  | UR          | SR          | *           | GLOSS         |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ɑ</td>
<td>/bɑrd/</td>
<td>['bɑːɖ]</td>
<td>*[ˈbɑːɖ]</td>
<td>‘bard’</td>
<td></td>
</tr>
<tr>
<td>u</td>
<td>/ɜrna/</td>
<td>['ɜːɳa]</td>
<td>*[ˈɜːɳa]</td>
<td>‘urn’</td>
<td></td>
</tr>
<tr>
<td>ε</td>
<td>/əerna/</td>
<td>['ɛːɳa]</td>
<td>*[ˈɛːɳa]</td>
<td>‘with pleasure’</td>
<td></td>
</tr>
<tr>
<td>y</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>/ɛrde/</td>
<td>['ɛːɖɛ]</td>
<td>*[ˈɛːɖɛ]</td>
<td>‘shepherd’</td>
<td></td>
</tr>
<tr>
<td>o</td>
<td>/ɔrla/</td>
<td>['ɔːɭa]</td>
<td>*[ˈɔɭːa]</td>
<td>‘murmur’</td>
<td></td>
</tr>
<tr>
<td>u</td>
<td>/ɔrn/</td>
<td>['ʊŋ]</td>
<td>*[ˈʊŋ]</td>
<td>‘horn’</td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>/ɛrd/</td>
<td>['ɪɖ]</td>
<td>*[ˈɪɖ]</td>
<td>‘housecarl’</td>
<td></td>
</tr>
<tr>
<td>ø</td>
<td>/ɔrd/</td>
<td>['ɔːɖ]</td>
<td>*[ˈɔːɖ]</td>
<td>‘lineage, descent’</td>
<td></td>
</tr>
</tbody>
</table>

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

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28 Recall that unstressed vowels are always short.

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[ɔ̃]t| *s[õt]| ‘type, sort’  
/vord/  | v[ɔ̃d]| *v[ɔ̃d]| ‘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  
---|---|---|---  
/sod:/  | s[ɔ̃d]| *s[õd]| ‘sowed’  
/mot:/  | m[ɔ̃t]| *m[õt]| ‘measure’

By the same token, a tense vowel precedes a short consonant, independent of its voicing.
(200) | UR | SR | * | GLOSS |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>/nod/</td>
<td>n[ɔːɻ]d</td>
<td>*n[ɔːɻ]d</td>
<td>‘mercy’</td>
</tr>
<tr>
<td>/vot/</td>
<td>v[ɔːɻ]t</td>
<td>*v[ɔːɻ]t</td>
<td>‘wet’</td>
</tr>
</tbody>
</table>

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/ [d̪n̩]_

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/ [d̪n̩]_

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

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) $^{*}\text{r} [+\text{cor}]$

[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) $[+\text{LONG}] \leftrightarrow [+\text{TENSE}]$

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) $\text{IDENT} [\text{tense}]$

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.
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.
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:

\[(208)\]

\[
\sigma_{\mu\mu} \leftrightarrow [+\text{stress}]
\]

\[
* C_{\mu} / [d, n, l] \leftrightarrow [+\text{LONG}]
\]

\[
[+\text{LONG}] \leftrightarrow [+\text{TENSE}]
\]

\[
*r[+\text{cor}]
\]

\[
\Rightarrow \quad \text{IDENT [TENSE]}
\]

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:
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.

The same problem arises for the word for ‘Kurd’:
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)
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 \([a, ø]\) block coalescence of voiced post-alveolars. In most dialects, coalescence is blocked in the following words:

<table>
<thead>
<tr>
<th>VOWEL</th>
<th>STANDARD FORM</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>[a]</td>
<td>['gaₜrd]</td>
<td>*['ɡɑːtːd]</td>
</tr>
<tr>
<td>[a]</td>
<td>[bil'jaₜrd]</td>
<td>*[bil'jɑːtː]</td>
</tr>
<tr>
<td>[a]</td>
<td>[bolɒ'vaₜrd]</td>
<td>*[bolɒl'vɑːtː]</td>
</tr>
<tr>
<td>[ø]</td>
<td>[ap'sətːrd]</td>
<td>*[ap'suːtː]</td>
</tr>
</tbody>
</table>

Blocked coalescence is unattested with other vowels. The following chart shows words which feature coalesced coronals after the other vowels, modulo one accidental gap:
\[(215)\]

<table>
<thead>
<tr>
<th>V</th>
<th>UR</th>
<th>SR</th>
<th>*</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ɛ</td>
<td>/jĕrna/</td>
<td>['jeːna]</td>
<td>*[jĕr̝na]</td>
<td>‘with pleasure’</td>
</tr>
<tr>
<td>y</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>e</td>
<td>/herde/</td>
<td>['heːɖe]</td>
<td>*[hɛrd̝e]</td>
<td>‘shepherd’</td>
</tr>
<tr>
<td>o</td>
<td>/porl/</td>
<td>[poːɭ]</td>
<td>*[pɔrl]</td>
<td>‘murmur’</td>
</tr>
<tr>
<td>u</td>
<td>/hurn/</td>
<td>[huːɳ]</td>
<td>*[horn]</td>
<td>‘horn’</td>
</tr>
<tr>
<td>i</td>
<td>/hird/</td>
<td>[hiːɖ]</td>
<td>*[hırd̝]</td>
<td>‘housecarl’</td>
</tr>
<tr>
<td>ø</td>
<td>/bœrda/</td>
<td>['bœrd̝a]</td>
<td>*[bɔrd̝a]</td>
<td>‘burden’</td>
</tr>
</tbody>
</table>

It appears, then, that the IDENT [tense] constraint patterns differently for the vowels [a, ø] than for other vowels. In particular, IDENT [tense] /a and IDENT [tense] /ø 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] /ø
\[\implies\] *r[+cor]
\[\implies\] 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,
\( \theta \) 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 [\( \theta \)] 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 [a] and the distance between lax [\( \theta \)] and tense [u] are greater than the distance between other lax vowels and their alternating tense vowel.

Elert notes the articulatory differences between the pairs [a, a] and [\( \theta \), u]. He places [a] in the low central region of the vowel chart (Elert 1979:36), whereas [a] is low back. Furthermore, the vowel [a] 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 ([u]) …is a front vowel, which in the vowel chart can be placed very close to [e]. The long Swedish u-sound ([u]) is however hyperround, even more rounded than the long \( \partial \)-sound ([\( \partial \)]). The short u-sound ([\( \partial \)])…is a rounded…mid high central vowel.\(^{30}\)

So the vowels [\( \theta \), u] differ in frontness and hyperrounding. Furthermore, Elert (1979:37) notes that [u] is often diphthongized, with a [\( \beta \)] offglide. Short [\( \theta \)] 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 placeras helt nära [e]. Det långa svenska u-ljudet är emellertid överrundat, än mer rundat än långt \( \partial \)-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 \([a_l, a_r]\) and \([o_l, u_r]\) is frequently noted in the Swedish phonetic and phonological literature. Linell (1978:128) notes that differences 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 \(a\) ([aː] vs. [a]) and \(u\) ([uː] vs. [ʊ])).

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 [aː] compared to [a] or [oː] compared to [ɔ] or [uː] compared to [ʊ]. 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 [oː] and [ʊ].

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

Listening tests showed that length was the main cue for the pairs [vɛːɡ] / [vɛɡ] and [stʊːta] / [stʊta]: however, for [fʊːl] / [fɔːl], 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 [u] with the symbol [u].
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 [ɑ] and tense [ʊ] as well as between lax [ø] 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.

<table>
<thead>
<tr>
<th></th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\alpha_T)</td>
<td>523</td>
<td>859</td>
<td>2480</td>
</tr>
<tr>
<td>(\alpha_L)</td>
<td>701</td>
<td>1342</td>
<td>2439</td>
</tr>
<tr>
<td>(\upsilon_T)</td>
<td>328</td>
<td>1733</td>
<td>2453</td>
</tr>
<tr>
<td>(\upsilon_L)</td>
<td>411</td>
<td>1223</td>
<td>2493</td>
</tr>
<tr>
<td>(\varepsilon_T)</td>
<td>590</td>
<td>1650</td>
<td>2711</td>
</tr>
<tr>
<td>(\varepsilon_L)</td>
<td>451</td>
<td>1945</td>
<td>2816</td>
</tr>
<tr>
<td>(\gamma_T)</td>
<td>285</td>
<td>2258</td>
<td>2994</td>
</tr>
<tr>
<td>(\gamma_L)</td>
<td>364</td>
<td>1919</td>
<td>2697</td>
</tr>
<tr>
<td>(\epsilon_T)</td>
<td>385</td>
<td>2194</td>
<td>2920</td>
</tr>
<tr>
<td>(\epsilon_L)</td>
<td>451</td>
<td>1945</td>
<td>2816</td>
</tr>
</tbody>
</table>
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 \( F_2' \) from F1, F2, and F3.

\[
F_2' = F_2 + \frac{D_1 F_1}{(F_2 - F_1)} + \frac{D_2 F_3}{(F_3 - F_2)}
\]

In this equation, \( D_1 = 164.9 \) and \( D_2 = 33.3 \). By transforming the formant values into Bark, and weighting \( F_2' \) 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.\(^{34}\)

\[\begin{array}{lll}
\text{o}_T & 388 & 711 & 2741 \\
\text{ɔ}_L & 453 & 834 & 2628 \\
\text{u}_T & 299 & 678 & 2707 \\
\text{ʊ}_L & 350 & 763 & 2634 \\
\text{i}_T & 275 & 2363 & 3304 \\
\text{ɪ}_L & 332 & 2241 & 3000 \\
\text{o}_T & 491 & 1439 & 2506 \\
\text{ø}_L & 492 & 1332 & 2519 \\
\end{array}\]

\(^{34}\) An attempt at establishing these scales perceptually is discussed in section 6.10 and 6.11.
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):
A formalism for relating perceptual distances and correspondence relations is found in Zuraw’s *MAP. Zuraw’s *MAP constraint rules out correspondences:

\[(221) \quad *\text{MAP}\ S_1S_2 \ (\ ^aX^B,\ ^cY^D) \quad (\text{Zuraw 2007})\]

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:

\[(222) \quad \text{Distance-to-ranking projection (Zuraw p.c.)} \quad 35\]

If \[\Delta(^aX^B,\ ^cY^D) \gt \Delta(^aX'^B,\ ^cY'^D)\]
then *MAP S_1S_2 \ (\ ^aX^B,\ ^cY^D) \ \gg \ *MAP S_1S_2 \ (\ ^aX'^B,\ ^cY'^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:

\[(223) \quad \begin{align*}
\text{LAX-TO-TENSE} & \\
*\text{MAP} (a_l,\ a_T) & \gg *\text{MAP} (\theta_L,\ u_T) \\
& \gg *\text{MAP} (\epsilon_L,\ \epsilon_T) \\
& \gg *\text{MAP} (\gamma_L,\ y_T) \\
& \gg *\text{MAP} (\epsilon_L,\ e_T) \\
& \gg *\text{MAP} (\alpha_L,\ o_T) \\
\text{TENSE-TO-LAX} & \\
& \gg *\text{MAP} (a_T,\ a_l) \\
& \gg *\text{MAP} (u_T,\ \theta_L) \\
& \gg *\text{MAP} (\epsilon_T,\ \epsilon_L) \\
& \gg *\text{MAP} (y_T,\ \gamma_L) \\
& \gg *\text{MAP} (e_T,\ \epsilon_L) \\
& \gg *\text{MAP} (o_T,\ \alpha_L)
\end{align*}\]


36 I will abstract away from environmental indices in my account, since they are not relevant to the issues being discussed.

109
By interleaving $^*r[ + \text{cor}]$ in the first ranking in (223), the following scale is obtained:

(224)  

\[ *\text{MAP} \ (a_L, a_T) \]
\[ *\text{MAP} \ (\theta_L, u_T) \]
\[ *\text{MAP} \ (\emptyset L, \emptyset T) \]
\[ r[ + \text{cor}] \quad \leftarrow \text{interleaved}. \]
\[ *\text{MAP} \ (\varepsilon_L, \varepsilon_T) \]
\[ *\text{MAP} \ (y_L, y_T) \]
\[ *\text{MAP} \ (\varepsilon_L, e_T) \]
\[ *\text{MAP} \ (\sigma_L, \sigma_T) \]
\[ *\text{MAP} \ (u_L, u_T) \]
\[ *\text{MAP} \ (i_L, i_T) \]
\[ *\text{MAP} \ (\emptyset L, \emptyset T) \]

Now consider the tableaux for ‘guard’, to see how the correct outputs are generated:
Consider candidates (d) and (e). Different vowels have different rankings of *M\text{AP}, and *M\text{AP} (a_{t} \alpha_{r}) 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 *M\text{AP} (a_{t} \alpha_{r}) and *M\text{AP} (\theta_{l} \theta_{r}), *M\text{AP} (\theta_{l} \theta_{r}) 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.
The remaining vowels pattern like [ø], with the relevant *Map constraint ranked lower than *r[ + cor].

There are also words with the tense [a] or [u] followed by coalesced voiced post-alveolars. For example, chart (197) above included [\'bɔːrd\] ‘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., /bɔːrd/, so there is no violation of *Map in this output.

<table>
<thead>
<tr>
<th>/bɔːrd/</th>
<th>‘lineage, descent’</th>
<th>a. bɔːrd</th>
<th>b. bɔːrd</th>
<th>c. bɔːrd</th>
<th>d. bɔːrd</th>
<th>e. bɔːrd</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+stress</td>
<td>[−stress]</td>
<td>+LONG</td>
<td>[−LONG]</td>
<td>+TENSE</td>
<td>[−TENSE]</td>
</tr>
<tr>
<td></td>
<td>Cµ/</td>
<td>[q.µ]</td>
<td>[−q.µ]</td>
<td>[−q.µ]</td>
<td>[−q.µ]</td>
<td>[−q.µ]</td>
</tr>
<tr>
<td></td>
<td>*Map</td>
<td>*Map</td>
<td>*Map</td>
<td>*Map</td>
<td>*Map</td>
<td>*Map</td>
</tr>
<tr>
<td></td>
<td>(a, a)</td>
<td>(a, a)</td>
<td>(a, a)</td>
<td>(a, a)</td>
<td>(a, a)</td>
<td>(a, a)</td>
</tr>
<tr>
<td></td>
<td>(θ, θ)</td>
<td>(θ, θ)</td>
<td>(θ, θ)</td>
<td>(θ, θ)</td>
<td>(θ, θ)</td>
<td>(θ, θ)</td>
</tr>
<tr>
<td></td>
<td>(r[ + cor])</td>
<td>(r[ + cor])</td>
<td>(r[ + cor])</td>
<td>(r[ + cor])</td>
<td>(r[ + cor])</td>
<td>(r[ + cor])</td>
</tr>
<tr>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

| a. bɔːrd | *        |
| b. bɔːrd | *        |
| c. bɔːrd | *        |
| d. bɔːrd | *        |
| e. bɔːrd | *        |
4.5 Blocked laxing with voiceless post-alveolars

4.5.1 Data

Just as the mapping from \([a_\text{L}] \rightarrow [\alpha_\text{T}]\) results in exceptional phonotactic patterns before the cluster \([rd]\), the reversed mapping \([\alpha_\text{T}] \rightarrow [a_\text{L}]\) results in exceptional phonotactic patterns before the derived post-alveolar segments \([\text{s}]\) and \([\text{t}]\).

The clusters \([rs]\) and \([rt]\) generally coalesce into voiceless post-alveolar segments \([\text{s}]\) and \([\text{t}]\), respectively. In stressed syllables, these post-alveolars are long; the preceding stressed vowel is short. The following chart illustrates the pattern:

\[
\begin{array}{|l|c|c|c|c|}
\hline
\text{UR} & \text{SR} & * & \text{GLOSS} \\
\hline /\text{fars}/ & [f\text{a}s:] & *[f\text{a}s] & \text{‘farce’} \\
/f\text{ors}/ & [f\text{o}s:] & *[f\text{o}s] & \text{‘rapids’} \\
/b\text{o}rs/ & [b\text{o}s:] & *[b\text{o}s] & \text{‘stock exchange’} \\
/k\text{ort}/ & [k\text{ort}:] & *[k\text{ort}] & \text{‘Kurt, a name’} \\
/myrten/ & [\text{'myr}:\text{en}] & *[\text{'myr}:\text{en}] & \text{‘myrtle’} \\
\hline
\end{array}
\]
The prohibition against short voiceless post-alveolars may be stated using the following constraint:

(229) \*C-µ / [\$ t]  

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)

<table>
<thead>
<tr>
<th>/fɔɨɾs/</th>
<th>‘rapids’</th>
<th>o[µ] ↔ [+stress]</th>
<th>[+LONG] ↔ [+TENSE]</th>
<th>*[+cor]</th>
<th>*C-µ/ [+st]</th>
<th>*MAP (ɔL, ɔr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. fɔɨɾʂː</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. fɔɨɾʂː</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. fɔɨɾs</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. fɔɨɾʂː</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>e. ≥ fɔɨɾʂː</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If, on the other hand, the vowel is tense in UR, we must assume that \*C-µ/[\$ t]  

⇒ *MAP (ɔL, ɔr), to ensure that the unfaithful mapping of the vowel serves as the optimal candidate.
4.5.2 Exceptional vowel length before [s t]

Not all vowels pattern like the pair [ɔt ɔ阻力] above. There are some words where the constraint *C-m/ [s t] is violated, and the *MAP constraint is obeyed. The result is that the derived post-alveolars [s t] surface as short, and the preceding stressed vowel is long. Consider the following examples:

(232)  *CORRESP.  UR  SR  *  GLOSS

*  a → a  /lars/  [lɑːs]  *[lɑːʃ]  ‘a name’
*  a → a  /art/  ['aːt]  *[aːt]  ‘kind, sort’
*  a → a  /smart/  ['smaːt]  *[smaːt]  ‘smart’
*  a → a  /fart/  ['fæt]  *[fæt]  ‘speed’
*  a → a  /arta/  ['aːtə]  *[aːtə]  ‘to shape’
*  a → a  /karta/  ['kɑːtə]  *[kɑːtə]  ‘map’
Recall that we established above that \( *C_{-µ}/[ʂ \ t] \gg *\text{MAP} (α_1, o) \). If we naively assumed that all vowels had the same \(*\text{MAP}\) constraint for the lax-to-tense mapping, this would imply that \( *C_{-µ}/[ʂ \ t] \gg *\text{MAP} (α_1, α_1) \); but this generates the wrong output:

(233)

<table>
<thead>
<tr>
<th>/la₁ːʂ/</th>
<th>*C_{-µ}/[ʂ \ t]</th>
<th>( *\text{MAP} (a_1, a_1) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ( la_{1}:ʂ; )</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. ( la_{1}:ʂ; )</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. ( la_{1}:ʂ; )</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>d. &gt; ( la_{1}:ʂ )</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>e. ( l a_{1}:ʂ; )</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Just as blocked coalescence of voiced post-alveolars provides evidence for distinct \(*\text{MAP}\) 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 [a]. There are no exceptional forms with the rime [u:ʂ] or [u:ʈ]. I will assume that this is an accident, to maximize parallelism with exceptional blocked coalescence, discussed in the preceding chapter.

4.5.3 \(*\text{MAP}\) with an interleaved constraint

Recall the \(*\text{MAP}\) projection mechanism, as applied to the mapping from tense to lax vowels, which was discussed above:
If we interleave *C-µ/ [§ t], such that it is ranked lower than *MAP (α_T, α_L) and *MAP (u_T, θ_L), we obtain the following ranking:

(235)  
\*MAP (α_T, α_L) 
\> *MAP (u_T, θ_L) 
\> *C-µ/ [§ t] \leftarrow interleaved. 
\> *MAP (ε_T, ε_L) and all other vowel pairs

This ranking provides the correct output for the name ‘Lars’—which surfaces with a long tense vowel.
The ranking also generates the correct output for the other vowels, which surface with a short vowel, as the following tableau for ‘rapids’ illustrates:

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’ [faːɾːs] 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)

<table>
<thead>
<tr>
<th>/faːɾːs/</th>
<th>+stress</th>
<th>+LONG</th>
<th>+TENSE</th>
<th>*T+cor</th>
<th>*MAP (aᵣ, a₂)</th>
<th>*MAP (Cᵣ, Sᵣ)</th>
<th>*MAP (oᵣ, a₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. faːɾːsː</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. faːɾːsː</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. faːɾːs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. faːɾːsː</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. &gt; faːɾːsː</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.6 Blocked laxing before geminate suffixes: verbs

4.6.1 Third conjugation: C₀V 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:
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_0V, grouped by vowel:\(^{37}\)

<table>
<thead>
<tr>
<th>CORRESP.</th>
<th>#ATTESTED</th>
<th>STEM</th>
<th>SUP</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>α_T → a_L</td>
<td>0 (PREDICTED)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>u_T → o_L</td>
<td>0 (PREDICTED)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>e_T → e_L</td>
<td>3</td>
<td>kl[e:]</td>
<td>kl[e]:</td>
<td>‘clothe’</td>
</tr>
<tr>
<td>y_T → y_L</td>
<td>6</td>
<td>'br[y:]</td>
<td>'br[y]:</td>
<td>‘care’</td>
</tr>
<tr>
<td>e_T → e</td>
<td>5</td>
<td>'j[e:]</td>
<td>'j[e]:</td>
<td>‘occur’</td>
</tr>
<tr>
<td>o_T → o_L</td>
<td>10</td>
<td>'fl[o:]</td>
<td>'fl[o]:</td>
<td>‘flay’</td>
</tr>
<tr>
<td>u_T → u_L</td>
<td>11</td>
<td>'gn[u:]</td>
<td>'gn[u]:</td>
<td>‘rub’</td>
</tr>
<tr>
<td>i_T → i_L</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>o_T → o_L</td>
<td>2</td>
<td>'str[o:]</td>
<td>'str[o]:</td>
<td>‘sprinkle’</td>
</tr>
</tbody>
</table>

The vowels [α_T a_L] and [u_T o_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 $[\alpha_T, \alpha_L]$ and $[\upsilon_T, \upsilon_L]$ are not attested in this group.  

<table>
<thead>
<tr>
<th>CORRESP.</th>
<th>#ATTTESTED</th>
<th>STEM</th>
<th>SUPINE</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_T \rightarrow \alpha_L$</td>
<td>0 (PREDICTED)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>$\upsilon_T \rightarrow \upsilon_L$</td>
<td>0 (PREDICTED)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>$\varepsilon_T \rightarrow \varepsilon_L$</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>$\upsilon_T \rightarrow \upsilon_L$</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>$\epsilon_T \rightarrow \epsilon_L$</td>
<td>4</td>
<td>b[e:]</td>
<td>b[ɛ]:t</td>
<td>‘pray’</td>
</tr>
<tr>
<td>$\omega_T \rightarrow \omega_L$</td>
<td>3</td>
<td>f[o:]</td>
<td>f[ɔ]:t</td>
<td>‘get’</td>
</tr>
<tr>
<td>$\mu_T \rightarrow \mu_L$</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>$i_T \rightarrow i_L$</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>$\sigma_T \rightarrow \sigma_L$</td>
<td>1</td>
<td>d[ø:]</td>
<td>d[ø]:t</td>
<td>‘die’</td>
</tr>
</tbody>
</table>

These gaps are not due to a lack of stems of the form $C_0\alpha$. $C_0\alpha$ 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.
In no part of the paradigm does the correspondence [ɑT, aL] take place.

4.6.3 Second conjugation: C0Vd and C0Vt stems

The vowels in verbal stems of the form C0Vd and C0Vt undergo tense/lax alternation when the stem associates with a geminate-initial suffix. The following illustrate stems of the form C0Vd.

<table>
<thead>
<tr>
<th>INF</th>
<th>SUPINE</th>
<th>PARTICIPLE</th>
<th>PRETERITE</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>[tɑː]</td>
<td>[tɑːgit]</td>
<td>[tɑːɡən]</td>
<td>[tuːɡ]</td>
<td>‘take’</td>
</tr>
<tr>
<td>*[tadː]</td>
<td>*[tadː]</td>
<td>*[tadːə]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[draː]</td>
<td>[draːgit]</td>
<td>[draːɡən]</td>
<td>[drug]</td>
<td>‘pull’</td>
</tr>
<tr>
<td>*[dradː]</td>
<td>*[dradː]</td>
<td>*[dradːə]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following chart shows the same mapping among verbal stems of the form C0Vt.

<table>
<thead>
<tr>
<th>INF</th>
<th>SUPINE</th>
<th>PARTICIPLE</th>
<th>PRETERITE</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>'m[ɛːT]ta</td>
<td>'m[ɛːL]tː</td>
<td>'m[ɛːL]tː</td>
<td>'m[ɛːL]tːə</td>
<td>‘measure’</td>
</tr>
</tbody>
</table>

The verbal paradigms show a dispreference of alternation in the vowel pairs [ɑT, aL] and [uT, øL]. The following chart shows the distribution of regular words of the form C0Vd (‘second conjugation’) organized by vowel:\u201339

39 For a complete list, see appendix 3.
No words featuring the alternating vowels \( \alpha_t \rightarrow a_L \) and \( \upsilon_t \rightarrow \upsilon_L \) are attested.

This is not due to a lack of stems of the form \( C_0 \alpha \) or \( C_0 \upsilon \). Stems of the form \( C_0 \alpha \) 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:

\[
\begin{array}{cccc}
\text{STEM} & \text{SUPINE} & \text{PARTICIPLE} & \text{PRETERITE} & \text{GLOSS} \\
\text{[b\text{\textordmasculine}d]} & \text{['b\text{\textordmasculine}d]t} & \text{'b\text{\textordmasculine}dad} & \text{'b\text{\textordmasculine}dad\text{\textordmasculine}a} & \text{‘bathe'} \\
\quad \ast [b\text{\textordmasculine}t] & \ast [b\text{\textordmasculine}d] & \ast [b\text{\textordmasculine}d\text{\textordmasculine}a] & \\
\end{array}
\]

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 \( C_0 \upsilon \) 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.
In paradigms like this, tense [u] never alternates with its lax counterpart [ø].

Just as the vowels [ɑT, aL] and [uT, oL] are underrepresented in tenseness-shifting paradigms with stems of the form C0Vd (‘second conjugation’), they are also not represented in tenseness-shifting paradigms with stems of the form C0Vt (‘second conjugation’):⁴⁰

This is not due to a lack of stems of the form C0at and C0øt. 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.
Note how, once again, the vowel remains long and tense throughout the paradigm. It never alternates with the lax vowel.

Stems of the form C₀uT are also attested in the fourth conjugation, featuring ablaut:

<table>
<thead>
<tr>
<th>STEM</th>
<th>SUPINE</th>
<th>PARTICIPLE</th>
<th>PRETERITE</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>[hɑːt]</td>
<td>[ˈhɑːtː]</td>
<td>[ˈhɑːtː]</td>
<td>[ˈhɑːtːdə]</td>
<td>‘hate’</td>
</tr>
<tr>
<td>*[hatː]</td>
<td>*[hatː]</td>
<td>*[ˈhatːə]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[kʉːt]</td>
<td>[ˈkʉːtː]</td>
<td>[ˈkʉːtː]</td>
<td>[ˈkʉːtːdə]</td>
<td>‘run’</td>
</tr>
<tr>
<td>*[kətː]</td>
<td>*[kətː]</td>
<td>*[ˈkətːə]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As expected, tense [u] never alternates with its lax counterpart [o].

4.7 Blocked laxing before geminate suffixes: adjectives

4.7.1 C₀V stems

Some Swedish adjectives of the form C₀V feature tense/lax alternation when a geminate neuter suffix is affixed.

<table>
<thead>
<tr>
<th>STEM</th>
<th>NEUTER</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>n[yː]</td>
<td>n[yː]tː</td>
<td>‘new’</td>
</tr>
</tbody>
</table>

The vowel pairs [a̞, a] and [u̞, o̞] are underrepresented in these paradigms.41

41 For a complete list, see Appendix 5. Lists are obtained from Holmes & Hinchliffe 1994.
Note that this is not due to a lack of stems of the form $C_0\alpha$. The word [brɑː] ‘good’ is a familiar word in the Swedish lexicon. Strikingly, the neuter of the word features an exceptional null suffix:

\[
\begin{array}{cccc}
\text{CORRESP.} & \text{STEM} & \text{NEUTER} & \text{GLOSS} \\
\alpha_T \rightarrow a_L & 0 \text{ (PREDICTED)} & -- & -- \\
\varepsilon_T \rightarrow \varepsilon_L & 0 & -- & -- \\
y_T \rightarrow y_L & 1 & n[y:] & \text{‘new’} \\
e_T \rightarrow \varepsilon & 0 & -- & -- \\
o_T \rightarrow o_L & 3 & bl[\sigma:] & \text{‘blue’} \\
u_T \rightarrow u_L & 0 & -- & -- \\
i_T \rightarrow i_L & 1 & fr[i:] & \text{‘free’} \\
\emptyset_T \rightarrow \emptyset_L & 1 & sl[\emptyset:] & \text{‘lazy’} \\
\end{array}
\]

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 $C_0V$.

\[
\begin{array}{ccc}
\text{STEM} & \text{NEUTER} & \text{GLOSS} \\
br[e_T]d & br[\varepsilon_L]t: & \text{‘broad’} \\
h[e_T]t & h[\varepsilon_L]t: & \text{‘hot’} \\
\end{array}
\]
The vowels [ɑₜ, aₜ] and [ʉₜ, ɵₜ] are underrepresented in these paradigms. There is only one⁴² adjective with the alternation [ɑₜ, aₜ] among adjectives with the form CₒVd, and there is no adjective with the alternation [ʉₜ, ɵₜ] among these adjectives. The complete distribution is as follows:⁴³

<table>
<thead>
<tr>
<th>CORRESP.</th>
<th># ATTESTED</th>
<th>STEM</th>
<th>NEUTER</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>αₜ → aₜ</td>
<td>1</td>
<td>gl[ɑː]d</td>
<td>gl[aː]t</td>
<td>‘happy’</td>
</tr>
<tr>
<td>uₜ → oₜ</td>
<td>0 (PREDICTED)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>εₜ → εₜ</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>yₜ → yₜ</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>eₜ → eₜ</td>
<td>1</td>
<td>br[eː]d</td>
<td>br[eː]t</td>
<td>‘broad’</td>
</tr>
<tr>
<td>‘oₜ → oₜ</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>uₜ → uₜ</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>iₜ → iₜ</td>
<td>3</td>
<td>so’l[iː]d</td>
<td>so’l[iː]t</td>
<td>‘solid’</td>
</tr>
<tr>
<td>øₜ → øₜ</td>
<td>3</td>
<td>r[oː]d</td>
<td>r[oː]t</td>
<td>‘red’</td>
</tr>
</tbody>
</table>

Likewise, there is no regular adjective of the form CₒVt with the alternation [ɑₜ, aₜ] or [ʉₜ, ɵₜ]. The complete distribution of these adjectives, grouped by stressed vowel, is as follows:⁴⁴

<table>
<thead>
<tr>
<th>CORRESP.</th>
<th># ATTESTED</th>
<th>STEM</th>
<th>NEUTER</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>αₜ → aₜ</td>
<td>0 (PREDICTED)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>uₜ → oₜ</td>
<td>0 (PREDICTED)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>εₜ → εₜ</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>yₜ → yₜ</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

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.
Note that this is not due to a lack of lexical items of the form $C_0at$. The word for ‘lazy’ is [l$\alpha$:t], and this is famously ineffable in the neuter (Cederschiöld 1912; cited in Raffelsiefen 2002). Where we would expect an output of the form [lat:], there is instead a gap in the paradigm:

\[
\begin{array}{cccc}
\text{CORRESP.} & \text{STEM} & \text{NEUTER} & \text{GLOSS} \\
\ast a_T \rightarrow a_L & [l\alpha:t] & *[l\alpha:t] & \text{NULL PARSE ‘lazy’} \\
\end{array}
\]

The difference between the words of the form $C_0at$ 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 $[a_T, a_L]$ 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 ‘ʘ’ (Prince & Smolensky 1993/2004). So, for the word ‘lazy, n.’, the NULL PARSE candidate is the optimal candidate.
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.
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 [u, ø] 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 [u, ø] in the paradigms: the numbers were simply too small. It may seem suggestive that there are no adjectives of the structure Cₜɑ: in the regular adjectival
paradigms, resulting in correspondence between [a] and [a], but all other vowels are similarly underrepresented in the regular paradigms of the form C₀Vː, except [o, ə]: all other vowels have zero or only one word of the relevant form.

To establish that the vowels [a, a] and [u, θ] 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 [a, a] and [u, θ] 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)

<table>
<thead>
<tr>
<th>Other verbal and adjectival paradigms (not tenseness-shifting)</th>
<th>Dental gemination (tenseness-shifting)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[a, a] and [u, θ]</td>
<td></td>
</tr>
<tr>
<td>other vowels</td>
<td></td>
</tr>
</tbody>
</table>

I focused on words of the structure C₀Vː, C₀Vːd, and C₀Vːt. 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 [a, a] and [ʉ, ə]. 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

<table>
<thead>
<tr>
<th>CORRESP.</th>
<th>CV</th>
<th>ex.CV</th>
<th>CV:d</th>
<th>CV:t</th>
<th>CV</th>
<th>CV:d</th>
<th>CV:t</th>
<th>sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>aₜ → aₐ</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>ʉₜ → əₜ</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

total: 1

One regular adjective of the form C₀V:d 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

<table>
<thead>
<tr>
<th>CORRESP.</th>
<th>CV</th>
<th>ex.CV</th>
<th>CV:d</th>
<th>CV:t</th>
<th>CV</th>
<th>CV:d</th>
<th>CV:t</th>
<th>sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>eₜ → eₖ</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>yₜ → yₖ</td>
<td>6</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>eₜ → e</td>
<td>5</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>oₜ → əₜ</td>
<td>10</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>17</td>
</tr>
</tbody>
</table>
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)

<table>
<thead>
<tr>
<th>Dental gemination (tenseness-shifting)</th>
<th>Other verbal and adjetival paradigms (not tenseness-shifting)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ɑ, a] and [u, ɵ]</td>
<td>1</td>
</tr>
<tr>
<td>other vowels</td>
<td>73</td>
</tr>
</tbody>
</table>

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 [u] 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) $C_0V$: [brɑː] ‘good’ (unaffixed in neuter)

$C_0V;d$ [ɡrɔːd] ‘straight’ (ineffable in neuter)

$C_0V;t$ [lɑːt] ‘lazy’ (ineffable in neuter)

In total, there are 3 such adjectives.

The following chart lists adjectives of the form $C_0V;$, $C_0V;d$, or $C_0V;t$ featuring other vowels which are either unaffixed or ineffable in the neuter form.
(265) \( C_0 V \): [kry:] ‘healthy’ (ineffable in neuter)

\( C_0 Vd \) [vre:] ‘straight’ (ineffable in neuter)

\( C_0 Vt \) --

In total, there are 2 such adjectives.

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

(266)

<table>
<thead>
<tr>
<th></th>
<th>Dental gemination</th>
<th>Other verbal and adjectival paradigms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(tenseness-shifting)</td>
<td>(not tenseness-shifting)</td>
</tr>
<tr>
<td>[a, a] and [u, œ]</td>
<td>1</td>
<td>3 +</td>
</tr>
<tr>
<td>other vowels</td>
<td>73</td>
<td>2 +</td>
</tr>
</tbody>
</table>

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 [ru:] ‘row’ with the first conjugation [ru:-a] ‘amuse’:

(267)

<table>
<thead>
<tr>
<th>STEM</th>
<th>PARTICIPLE</th>
<th>SUPINE</th>
<th>PRETERITE</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>r[u:]-a</td>
<td>'r[u:]-a + d</td>
<td>'r[u:]-a + t</td>
<td>'r[u:]-a + d:</td>
<td>‘amuse’</td>
</tr>
</tbody>
</table>

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 [bluːd-a] ‘put blood on’ and [ruːt-a] ‘dig’:

(268) | STEM | PARTICLE | SUPINE | PRETERITE | GLOSS |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>'bl[ː]d-a</td>
<td>'bl[ː]d-a + d</td>
<td>'bl[ː]d-a + t</td>
<td>'bl[ː]d-a + də</td>
<td>'put blood on'</td>
</tr>
<tr>
<td>'r[ː]t-a</td>
<td>'r[ː]t-a + d</td>
<td>'r[ː]t-a + t</td>
<td>'r[ː]t-a + də</td>
<td>'dig'</td>
</tr>
</tbody>
</table>

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 [a] or [u].\(^{45}\) 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 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a:</td>
<td>0</td>
<td>6</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>u:</td>
<td>4</td>
<td>3</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>total</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The total number of first conjugation verbs of the form \(C_0V:\), \(C_0V:d\) and \(C_0V:t\) featuring the vowels [a, u] is 34.

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 something other than [a] or [u].\(^{46}\)

\(^{45}\) For specific examples, see appendix 8.
\(^{46}\) For specific examples, see appendix 9.
The total number of first conjugation verbs of the form $C_0V_1$, $C_0V_2$ and $C_0V_3$ featuring vowels other than $[\alpha, u]$ is 93. With the earlier observation, that the total number of first conjugation verbs of the form $C_0V_1$, $C_0V_2$ and $C_0V_3$ featuring the vowels $[\alpha, u]$ is 34, we can continue to fill out the matrix:

\[
\begin{array}{|c|c|c|c|c|}
\hline
\text{VOWEL} & C_0V_1 & C_0V_2 & C_0V_3 & \text{sum} \\
\hline
\varepsilon: & 5 & 2 & 6 & 13 \\
y: & 6 & 0 & 0 & 6 \\
e: & 2 & 2 & 13 & 17 \\
o: & 5 & 3 & 5 & 13 \\
u: & 4 & 4 & 9 & 17 \\
i: & 5 & 1 & 6 & 12 \\
o: & 6 & 4 & 5 & 15 \\
\hline
\text{total} & & & & 93 \\
\end{array}
\]

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 $[\alpha:]$ and tense $[u:]$ in its paradigm; there is no $[\alpha:]$-$[a]$ correspondence.
The following chart lists the number of fourth conjugation verbs of the form $C_0V:\alpha$, $C_0V:d$ and $C_0V:t$, where the vowel is $[\alpha]$ or $[u]$.\(^{47}\)

<table>
<thead>
<tr>
<th>VOWEL</th>
<th>CV:</th>
<th>CV:d</th>
<th>CV:t</th>
<th>sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$:</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>$u$:</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>total</td>
<td></td>
<td></td>
<td></td>
<td>11</td>
</tr>
</tbody>
</table>

The total number of words of this type is 11.

The following chart lists the number of fourth conjugation verbs of the form $C_0V:\epsilon$, $C_0V:d$ and $C_0V:t$, where the vowel is something other than $[\alpha]$ or $[u]$.\(^{48}\)

<table>
<thead>
<tr>
<th>VOWEL</th>
<th>CV:</th>
<th>CV:d</th>
<th>CV:t</th>
<th>sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\epsilon$:</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>$y$:</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>$e$:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$o$:</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>$u$:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$i$:</td>
<td>0</td>
<td>7</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>$\phi$:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>total</td>
<td></td>
<td></td>
<td></td>
<td>21</td>
</tr>
</tbody>
</table>

\(^{47}\) 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 [ʊ] was 11, we can complete the matrix started above.

(275)

<table>
<thead>
<tr>
<th></th>
<th>Dental gemination (tenseness-shifting)</th>
<th>Other verbal and adjectival paradigms (not tenseness-shifting)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ɑ, a] and [ʊ, ɵ]</td>
<td>1</td>
<td>3 + 34 + 11 = 48</td>
</tr>
<tr>
<td>other vowels</td>
<td>73</td>
<td>2 + 93 + 21 = 116</td>
</tr>
</tbody>
</table>

Applying Fisher’s Exact Test to this matrix, we establish that the vowel pairs [ɑ, a] and [ʊ, 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 (ɑ₇, a₇) ≫ M-PARSE, as the following tableau shows:
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.
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)

<table>
<thead>
<tr>
<th>/'algebra + isk/ ‘algebraic’ cf. SR ['algebra']</th>
<th>+stress °° [+]LONG [+]TENSE</th>
<th>*MAP (a_T, a_L)</th>
<th>M-PARSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. alge'bra, isk</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. alge'bra;i isk</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. &gt; alge'bra;i isk</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. ♦ ☺</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

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 $\gg$ *MAP (a_T, a_L). Such a ranking would result in candidate (c) being the winner in the last two tableaux:
However, this of course generates the wrong output for neuter of ‘lazy’:
Towards a solution

It appears that the *$\text{MAP}(\alpha_T, a_L)$ for ‘lazy, n.’ is ranked differently from the *$\text{MAP}(\alpha_T, a_L)$ for ‘algebraic’ and ‘nickname for Jan’. If we could separate the *$\text{MAP}(\alpha_T, a_L)$ constraints, and rank them differently with respect to M-PARSE, we could generate the correct outputs in the three distinct cases:
(282)

<table>
<thead>
<tr>
<th></th>
<th>/laːt + t/</th>
<th>[ + stress ]</th>
<th>[ + LONG ]</th>
<th>*MAP (gr₃₊₄)</th>
<th>M-PARSE</th>
<th>*MAP (gr₃₊₄)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>laːt:t</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>laːt:t</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>laːt:t</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>&gt; ø</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(283)

<table>
<thead>
<tr>
<th></th>
<th>CVC:ə</th>
<th>[ + stress ]</th>
<th>[ + LONG ]</th>
<th>*MAP (gr₃₊₄)</th>
<th>M-PARSE</th>
<th>*MAP (gr₃₊₄)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>jaːnːə</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>jaːnːə</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>&gt; jaːnːə</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>ø</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 –isks 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 \(*MAP (X,Y)/+INFL \gg*MAP (X,Y)/-INFL\). 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 (ɑᵣ, aₙ)/(+INFL) ≫ *MAP (ɑᵣ, aₙ)/-INFL. The unfaithful mapping from [ɑᵣ] to [aₙ] 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)

<table>
<thead>
<tr>
<th></th>
<th>*/lₐₜːt + t:/</th>
<th>‘lazy, n.’</th>
<th>cf. SR [lₐₜːt]</th>
<th>*Mₜₜₜ[+stress]</th>
<th>[+LONG] ↔ [+TENSE]</th>
<th>*MAP (ɑᵣᵣᵣ, a₈ₕₕₕ)</th>
<th>+INFL</th>
<th>M-PARSE</th>
<th>*MAP (ɑᵣᵣᵣ, a₈ₕₕₕ)</th>
<th>-INFL</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>lₐₜːt:</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>lₐₜːt:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>lₐₜːt:</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>&gt; ʘ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This also generates the explicit output for the nickname for [jaːn], which is [janːɔ]. 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 ‘ʘ’.
The same constraint generates the explicit output for –isk form generated with the stem [algebra], which is [algebraisk]. Again, this is a derivational form, and the relevant *MAP constraint is ranked lower than M-PARSE.
The ordering paradox presented at the beginning of the section is resolved by splitting the \(*\text{MAP}\) constraints into two types, \(*\text{MAP} (X,Y)/+\text{INFL}\), which applies to inflectional forms, and \(*\text{MAP} (X,Y)/-\text{INFL}\), 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 \(*\text{MAP}\) constraints. We noted above the relative ranking \(*\text{MAP} (\alpha_T, \alpha_L)/+\text{INFL} \gg *\text{MAP} (\alpha_T, \alpha_L)/-\text{INFL}\. Notice that the feature \(\pm\text{INFL}\) is a marker of grammatical category. Recall also that the ranking mechanism for the \(*\text{MAP}\) constraints makes direct reference to primary content; i.e., perceptual distance:

\[(288) = (222) \quad \text{If} \quad \Delta(\text{AXB}, \text{CYD}) > \Delta(\text{AXB}', \text{CYD}') \quad \text{then} \quad *\text{MAP} S_1 S_2 (\text{AXB}, \text{CYD}) \gg *\text{MAP} S_1 S_2 (\text{AXB}', \text{CYD}')\]

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).

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 word-final 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 [lɑːt].
Crucially, Raffelsießen does not relativize the O-O IDENT to paradigm type. This constraint with its ranking predicts that the vowels [aː] 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:

\[(292)\]

<table>
<thead>
<tr>
<th>CVCːə</th>
<th>O-O IDENT [BACK]</th>
<th>M-PARSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘nickname for Jan’</td>
<td>cf. SR [jɑːn]</td>
<td></td>
</tr>
<tr>
<td>a. &gt; jaₐnːə</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

This is problematic: we saw above that they the vowels [aː] and [a] do alternate in nicknames. By the same token, that constraint ranking predicts that the vowels [aː] and [a] should not alternate in –isk formations:
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 S₁S₂ (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.
[hoːt]  [hoːt]  (order randomized)
[hoːt]  [hoːt]  (order randomized)

[heːt]  [heːt]  (order randomized)
[heːt]  [heːt]  (order randomized)

[hɔːt]  [hɔːt]  (order randomized)
[hɔːt]  [hɔːt]  (order randomized)

[huːt]  [huːt]  (order randomized)
[huːt]  [huːt]  (order randomized)

[hoːt]  [hoːt]  (order randomized)
[hoːt]  [hoːt]  (order randomized)
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