The Competitive Tier

Element subtraction in German and Pomeranian

(Axiomatic version)

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Abstract

Competition of segmental material is inherent in all proposals of phonological template satisfaction. Segments are aligned with a prosodic template and compete for prosodic space. In this paper, we argue that competition is also present in West-Germanic languages, albeit in disguised form. Basing ourselves on new Pomeranian data, we propose a competitive vocalic tier on which elements compete for prosodic slots besides the well-known vocalic tier that allows for element coalescence. An axiomatic model is developed that predicts alternations such as the [ai]-[i] and [e]-[i] root alternation (German treten-tritt 'he step(s), Pomeranian gaita-git 'he pour(s)'). The model allows us to solve three riddles in German morphology: 1. the "epenthesis conundrum", i.e. the anti-correlation between OCP-driven schwa epenthesis between root and suffix in German (rett[ə]-rett versus *rät[ə]-rät) and root alternations in present tense verbs (alternating verbs): retten-er rettet, raten - (er) rät (Neef 1997, Trommer 2010, Scheer 2016); 2. the "imperative conundrum" (Raffelsiefen 2016), which describes a correlation within the class of alternating verbs: the correlation between |A|-subtraction in a subset of alternating verbs (geben-gibt 'give(s)') and ending-less imperatives in German (gib! 'give!'); 3. the vowel shortening conundrum: change in quantity of the root vowel in function of the type of vowel alternation: [e:]-[i] versus [a:]-[e:]. A formal model is presented that provides us with a formal calculus of coalescence and competition of phonological features.

Keywords: subtractive morphology, Element Theory, umlaut/metaphony, autosegmental theory, ablaut.
Languages: High-German, Pomeranian, Dutch.
Introduction

Competition of segmental material is inherent in phonological proposals of template satisfaction (Goldsmith 1976, McCarthy 1978, Steriade 1982, Marantz 1982, and subsequent work): segments are aligned with a prosodic template and compete for prosodic space. For instance, a Semitic vocalic pattern P={ia} is aligned to a CVCVCV grid from left to right in according to the scheme in (1), producing kitaba. A pattern that is not produced is the pattern /kitiba/ where a vowel /i/ pushes /a/ to the third grid point, while spreading itself over two grid point. So there is first alignment (here: from-left-to-right) and then, as a last resort, spreading (again: from-left-to-right). Moreover, forms like ketaba are not produced either, where a and i occupy one prosodic slot.

\[
\begin{array}{cccc}
\text{pattern:} & \text{kitaba} & \text{pattern:} & \text{kitiba} \\
\text{CVCVCV} & \text{CVCVCV} & \text{CVCCVC} & \text{CVCCVC} \\
\text{melody:} & \text{i} & \text{a} & \text{i} & \text{a} \\
\{\text{ia}\} & \text{} & \text{} & \{\text{ia}\} & \text{}
\end{array}
\]

In this study we argue that competition in the search for prosodic space is also present in the vowel system of West Germanic languages. The effect is, compared to Arabic, less easy to detect because West Germanic has complex vowels, i.e. it has coalescence of vocalic material, which obscure the competition effect.

Competition effects in umlaut formation can be clearly observed in a West Germanic language, Pomeranian, spoken in the state Espirito Santo in Brazil. In comparing High German & Low Saxon plural morphology with Pomeranian, a curious pattern shows up. Consider the following singular-plural pairs, i.e. lemmas such as 'foot-feet', 'hat(s)', and 'book(s)' which is a systematic pattern in Continental Germanic dialects.

\[
\begin{array}{ccc}
\text{foot-feet} & \text{hat(s)} & \text{book(s)} \\
\text{a.} & \text{fu:s} - \text{fy:s} & \text{hu:t} - \text{hy:ts} & \text{bu:x} - \text{by:çɔr} & \text{High German} \\
\text{b.} & \text{fo:t} - \text{fo:c:ts} & \text{ho:d} - \text{he:c:(r)} & \text{bo:k} - \text{be:kɔ} & \text{Low Saxon}^1 \\
\text{c.} & \text{faut - fuit} & \text{haud} - \text{huir} & \text{bauk - buikɔr} & \text{Pomeranian}
\end{array}
\]

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1 In this paper, we refer to the Saxon dialects in the Netherlands (Nedersaksisch) by "Low Saxon" e.g. Den Ham and Enschede in the Dutch province of Overijssel (GRTP-database, locations G139, G234).
Both in High German and in Low Saxon, the plural is formed by adding a floating \( |l| \) element as a suffix to the stem (Lodge 1986, Wiese 1987, Anderson 2005, Hermans & Van Oostendorp 2008, Trommer 2010), apart from segmental material. In Low Saxon [o] transforms into [œ], in High German [u] transforms into [y]. Apparently, both variants apply i-umlaut. Now, when turning to Pomeranian in (3)c, the first thing that strikes is that no complex vowels are present. |A| and |U| in the singular \( faut \) are realized as distinct segments [fa"t], the broken form of the Low German /foot/. Similarly, in the plural \( fuit \), |U| and |I| are also realized as distinct segments [fu"t], the broken form of High German /füüs/\(^2\). The broken forms suggest that vocalic elements in Pomeranian do not coalesce. Significantly, upon addition of the extra (floating) |I| of the plural ("umlaut"), the A-element of the root\(^3\) is not realized: it is "pushed out" upon right-to-left alignment\(^4\) of the melody over the available grid points. |A| is "not parsed", because it is without grid point.

(4) (Pomeranian)

\[
\begin{array}{c|c|c|c|c|c}
|A| & |U| & |I| & |A| & |U| & |I| \\
\hline
f & \cdot & \cdot & t & + & \rightarrow & f & \cdot & \cdot & t \\
\end{array}
\]

\( faut \rightarrow fuit \)

The competition effect in (4) is wide-spread in Pomeranian morphology, both in inflection and derivation, for instance in denominal verbs: \( blaud 'blood' - bluir 'to bleed' \) (Postma 2016). Competition gives rise to subtractive effects in phonology: the addition of /i/ to \( faut \) causes a subtraction of /u/ from the root. Some roots in Pomeranian, however, do realize complex vowels, for instance \( h[ou]g -h[œ:]ger 'high(er)' \), \( dr[œ:]ga-hai dr[œ]gt 'to carry/he carries' \) with a short vowel, or words like \( hüüt 'today' \) (cf. Germ. \( heute 'today' \), Du. \( huid(ig) 'at present' \), which has a long complex vowel. Consequently, Pomeranian exhibits both competition and coalescence of vocalic material.

Modern German also exhibits competition effects in plural forms, albeit in less clear form, e.g. \( b[au]m-b[oi]me \), as illustrated in (5). The only difference with Pomeranian is that an extra |A| feature is superposed on it. As this element is not affected by the addition of the umlaut, it seems to be in another autosegmental dimension, i.e. on another tier.

\(^2\) The t-s alternation is an independent phonological sound law ("Second High German sound shift").

\(^3\) We respect the traditional opposition between 'root' and 'stem', where the root is a morpheme without category, being the basis of a stem under addition of a categorial theme (vowel). See also section 5.5.

\(^4\) So called "Edge-In" (Steriade 1982).
**The Competitive Tier**

(5) (German)

| A | | I | | A | | I |
|---|---|---|---|---|---|
| b • m + | | b • m baum → boime |

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| U | | I | | U | | I |
|---|---|---|---|---|---|
| b • m | | baum | | boime |

V1-tier

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Under (6) we give an example from the Limburgian dialect of Opglabbeek, *b[ou]m-b[ei]m* 'tree(s)' where an |U| element is expelled. Similar U-expulsion effects are found in Yiddish (Noam Faust, *pers. comm.*).

(6) (Opglapbeek)

| U | | I | | U | | I |
|---|---|---|---|---|---|
| b • m + | | b • m boum → beim |

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| U | | I | | U | | I |
|---|---|---|---|---|---|
| b • m | | baum | | boime |

V1-tier

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The question is then, how we disentangle the coalescent properties and the competing properties, empirically and theoretically. We argue that natural language allows for two vocalic tiers, one where elements are competitive and one where elements are coalescent, thus coalescing to complex vowels. We show that the assumption of competition side-by-side to coalescence provides us with a clue to solve two well-known but open riddles in German philology. We call the competitive tier *the V2-tier*. The usual (coalescent) vocalic tier is called the V1-tier. In general, we assume that two types of V-tiers are provided by UG and the choice between the type of tiers and the segmental filling of those tier is ruled by the lexicon. We summarize the proposal under (7).

(7)

- Natural language has two autosegmental vocalic tiers:
  - V1-tier is coalescent
  - V2-tier is competitive
- Competitive Principle
  Every grid point is linked to maximally one element on the V2-tier
- The umlaut factor (floating I-element) in West-Germanic realizes on the V2-tier
- Most lexical roots realize their vowels on the V1-tier, but some roots on the V2-tier ("breaking").

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5 GTRP, location L416p. The singular has accent 2 (level tone), the plural accent 1 (falling tone).
These assumptions create the possibility of apparent subtraction of phonological elements, under influence of standard additive morphological processes, as illustrated under (4)-(5) above. As we will see, it allows us to solve three riddles of German philology.

The article is structured as follows. First we will sketch three riddles in German philology, the imperative conundrum, the epenthesis conundrum, and the shortening conundrum (section 2). These riddles refer to two vowel alternations in verbal roots, $a\rightarrow e$ and $e\rightarrow i$. Section 3 is a brief historical background. Section 4 is theoretical and sketches the competitive tier model (CTM) in axiomatic form. It designs the mathematical structure of vowel vowel coalescence: a bound (semi-)lattice. It introduces the theoretical background of schwa, i.e. the element $|$@$. We explore the hypothesis that German and Pomeranian, and probably most languages, have coalescence and competition of elements, located on distinct tiers, a coalescent tier and a competitive tier. The application to German vowel alternation is given in section 5.1. Section 5.2 applies the model to the imperative conundrum, and in section 5.3, it is applied to the epenthesis conundrum. Section 5.4 deals with strong verbs that have epenthesis. Section 5.5 generalizes the model to weak verbs (the regular verb class), which is a trivial special case of the alternating verbs. Section 5.6 discusses an exceptional class with so-called rückumlaut. After the discussion of an apparent counterexample of the theory in section 6, we discuss the third conundrum, which we will not fully solve (section 7). In section 8, we confront the model with two previous accounts of the epenthesis conundrum: the declarative approach of Neef (1997), and the phonological approach of Trommer (2010). In section 9, we return to Pomeranian and apply the theory to the conundrums in this language. The speculative section 10 reflects on the relation of umlaut and ablaut. The paper closes off with summarizing the results, conclusions, and problems.

2 Three conundrums
In this section we describe three (related) riddles of German philology that link a seemingly mysterious distribution of schwa and stem alternating behaviour in verbal classes. One is the imperative conundrum, the other the epenthesis conundrum, the third is the shortening conundrum. Before turning to these, we must discuss a dimension of German morphology that concern the three. This is the phenomenon that the present tense shows root alternation for some verbs but not in others. In 23sg present tense the root vowel changes compared to the other forms of the paradigm. We call these alternating verbs. We list two typical examples in (8) next to three non-alternating verbs, sparen 'save', singen 'sing', and denken 'think', which lack root alternation in the present tense.
All alternating verbs are strong verbs, i.e. they show vowel alternation over the tenses, schlafen - schlief - geschlafen, and nehmen - nam - genommen, but non-alternating verbs can be strong (singen), weak (sparen), or mixed (denken).

2.1 The imperative conundrum

The imperative conundrum (Raffelsiefen 2016) concerns the shape of the imperative in alternating verbs such as raten and treten. While in non-alternating verbs, the sg imperative is formed by the verbal stem + schwa, a decision has been made which root variant is chosen in the class of alternating verbs. The stem vowel of imperative in the a-e class (the i-umlaut class) is derived from the stem vowel of the non-23sg form: rate-rätst-rät has rat(e)! as its imperative. In the e-i class (the a-umlaut class), on the other hand, the form of the imperative takes the stem vowel of the 23sg form as its basis: trete-trittst-tritt has tritt! as its imperative. Moreover, there is an effect on the shape of the suffix: ø in the case of the e-i class, optional (ə) in the case of the a-e class, and obligatory ø in the non-alternating class.

This conundrum, therefore, involves 1. the shape of the verbal stem, and 2. the shape of the ending, and 3. the correlation between these.

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6 German strictly distinguishes short [ɛ] and long [e:], but umlauted long /a/ is either realized as [e:] or [ɛ:], sometimes even within one speaker. Umlauted short /a/ is always realized as [ɛ].
2.2 The Epenthesis Conundrum

Just like English, German shows epenthesis when an ending clashes with the last consonant of a verbal root. In such cases a dummy vowel is added between final consonant and ending, e.g. spalt+t ('he splits') to be compared with English pass+s→pass[ə]s and hand+d→hand[ɪ]d.

This happens in various locations of the grammar, not only in the verbal system, for instance in adjectives, e.g. German groß-groß[ə]st, Eng. great-great[ə]st. At first glance, this is a rather late post-lexical phenomenon. However, this process depends on deep language properties as can be inspected from the closely related Dutch/Frisian/Flemish, raad+t→raadt, woest+st→woest, etc., which lack such epenthetic vowels. We come back to this. The curious thing is that the process is not even unconditioned within German. German shows a dependency between "late" schwa epenthesis and rather "early" morpho-phonological properties of the root. Without clash between dental plosive in ending and root and, there is no epenthesis, e.g. spiel+t→spielt. If there is a clash in roots that end in a dental plosive, as in spalten 'split', there must be epenthesis: spalt+t→spaltet. However, if the verb belongs to the alternating class, no schwa epenthesis happens, despite the clash, e.g. halt+t→hält (cf. Lessen Kloeke 1982, Wiese 1986:713, Scheer 2016). This anti-correlation is independent of the number of consonants and the vowel quality. Under (10) we give the distribution.

\[\text{(10) Alternating verbs in German}\]

\[
\begin{align*}
\text{a. spielen 'play'} & \quad \text{spiel- + t} \rightarrow \text{spielt} \\
& \quad \text{spiel- + st} \rightarrow \text{spielst} \\
\text{b. spalten 'split'} & \quad \text{spalt- + t} \rightarrow \text{spaltet} \\
& \quad \text{spalt- + st} \rightarrow \text{spaltetz} \\
\text{c. halten 'hold'} & \quad \text{hält- + t} \rightarrow \text{hält} \\
& \quad \text{hält- + st} \rightarrow \text{hältst} \\
\text{d. treten 'step'} & \quad \text{tritt- + t} \rightarrow \text{tritt} \\
& \quad \text{tritt- + st} \rightarrow \text{trittst} \\
\text{e. fechten 'fight'} & \quad \text{ficht + t} \rightarrow \text{ficht} \\
& \quad \text{ficht + st} \rightarrow \text{fichtst} \\
& \quad \text{or} \\
& \quad \text{fecht + t} \rightarrow \text{fechtet} \\
& \quad \text{fecht + st} \rightarrow \text{fechtet}
\end{align*}
\]

If a verb accidentally fluctuates between the alternating class and the non-alternating class, as fechten 'fight' does, the schwa epenthesis co-varies, as illustrated under (10)e. Mixed cases such as *fecht or *fichtet do not occur. This indicates that the relation between root alternation and absence of epenthesis is produced by synchronic grammar. So let us summarize the epenthesis conundrum under (11).
(11) **Epenthesis Conundrum**
- Alternating verbs do not show schwa epenthesis upon OCP clashes in 23sg present tense
- Non-alternating verbs (be they strong or weak) have the stem + schwa+ending as the 23sg present tense upon OCP clashes

\[ \text{er rät, tritt} \]
\[ \text{er bindet, sendet, leidet, spaltet, rettet, etc.} \]

In the next section we present the riddle concerning the length of the verbal stem.

2.3 **Shortening Conundrum**

While the stem vowels undergo a change in quality in 23sg present tense, they undergo a change in quantity in a subset of them. The pattern is, however, a mystery. While verbs without vowel alternation do not shorten, verbs with e-i alternation do: the vowel is a long \([e:]\) in *geben, nemen, treten*, and a short \([i]\) in the imperatives *gib!, nimmt!, tritt!*, as well as in 23sg present tense, e.g. *(er) gibt, nimmt, tritt.* In *schläfen, raten, etc.* however, which have an alternating long root vowel \([a:]\), no such shortening is observed, e.g. *schläft, rät, etc.* which has long \([e:]\) or \([e:\,\varepsilon:\]\). The empirical generalization is under (12).

(12) Alternating verbs of the a-i class do not display shortening
Alternating verbs of the e-i class do display shortening
\[ \text{schl[a:]fen} - \text{schl[e:]ft, r[a:]ten} \]
\[ \text{g[e:]ben} - \text{g[i]bt, tr[e:]ten} - \text{tr[i]tt} \]

This closes off our presentation of the three riddles that we aim to solve.

3 **Background**

In their discussion of apophony, Ségeral & Scheer (1998) discuss German ablauting verbs such as *binden-band-gebunden* 'bind-bound-bound' and identify a universal apophonic sequence I-A-U. If we assume autosegmental theory with a consonantal tier (not represented here) and a vocalic tier (Goldsmith 1976, McCarthy 1979), and if we assume the melodic content to be captured in Element Theory (Kay *et al.* 1985, Harris 1994, Backley 2011), we can represent this as in (13).\(^7\)

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\(^7\) For reasons of elegance, skeletal vocalic grid points are indicated with •. This is equivalent to the V or X in the earlier templatic literature.
We treat these three root forms as lexically related and part of the vocalic tier (but see section 10).

There is also a more complex case of I-A-U ablaut, as in helfen-half-geholfen 'to help', where the ablauting I-A-U sequence is superposed on, what Scheer calls, a "parasitic element", represented under (14), where the parasitic element is |A|, realized on another tier. As it is unaffected by changes on the tier that undergoes ablaut, we assume it to be in distinct planes (multiplanar approach, Archangeli 1985). While the ablauting vowel undergoes a change, the parasitic element remains constant.

This parasitic element in the case of helfen derives historically from an |A| element, which was part of a suffix and anchored to the root. Just as in the case in the previous section, we assume that these two levels represent two different vocalic tiers with distinct properties. We call these V1-tier and V2-tier, as in (15).

This parasitic element on the V2 tier has a relation with the suffix: the |A| in (15) originates from a suffix, which contained [a], e.g. OHG 13pl present tense -an. This |A| has spread to the stem and was later generalized over all persons and tenses: it became part of the root. This generalized |A| features the change from gehulfen to modern geholfen. It also shows that,

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8 i-umlaut did not affect verbs ending in a nasal cluster, cf. Braune/Reiffenstein (2004:35), but affected stems in clusters with /r/ and /l/. There might be a parallel to -en, which blocks i-umlaut in diminutives, while -el and -er are transparent to it. See also section 8.2.
synchronously, the relation in the present tense paradigm between /hilf-/ and /helf-/ is not A-umlaut anymore, i.e. addition of |A| to /hilf/, creating /helf/ (which is diachronically the case), but subtraction of |A| from /helf/ creating /hilf/ in synchrony. If hlf were the base form, we would expect the ablaut sequence hilf-half-hulf, counter to fact.

\[
\begin{array}{l|c|c|c|c|}
\text{schlafen} & \text{helfen} \\
\hline
1sg & schlafé & [a:] |A| & helfe & [e] |I|+|A| \\
2sg & schläft & [e:] |A|+|I| & hilfšt & [ɪ] |I| \\
3s & schläft & [e:] |A|+|I| & hilf & [ɪ] |I| \\
1pl & schlafen & [a:] |A| & helfen & [e] |I|+|A| \\
2pl & schlafft & [a:] |A| & helft & [e] |I|+|A| \\
3pl & schlaf & [a:] |A| & helfen & [e] |I|+|A| \\
\end{array}
\]

Notice that addition of |I| (i-umlaut) and subtraction of |A| in (16) pattern as if they were one and the same morphological process synchronically. Hence, we are trying to generalize over I-addition and A-subtraction in the 23sg forms of the present tense paradigm.

### 4 The competitive tier model: competition and coalescence using Element Theory

Segmental content of the grid points have been described by various theories of feature composition in the tradition of the Prague school, via Chomsky & Halle (1968) to modern theories of feature geometry. Here we adopt Element Theory (Kaye, Lowenstamm & Vergnaud 1985, Backley 2010). Element Theory is a theory of phonological features that are strictly monovalued ("privative"): they can be there or there is nothing, i.e. no negative values. As we exclusively discuss vowels, we limit ourselves to the space spanned by their place features. For further reference, we list some place features under (17). Vowels are built up by the basic features |A|, |I| and |U|. An extra element |@| is assumed with functions as a neutral element under (17)f (Harris 1994). In isolation |@| has [ə] as its exponent. Finally, we assume floating features (Lodge 1986, Wiese 1996), an element on a deactivated grid point, here illustrated as the floating |I| under (17)g, notated as fraktur character 𝝁.

\[\text{\textsuperscript{9}}\text{ We ignore length in this axiomatic section. Length and vowel shortening are dealt with in section 7.}\]
A floating element lacks an active anchoring grid point of its own (because of its lexical specification). Such a melody without prosodic space is in search of space. This is parallel to Rubach 1986's theory of yers as vowels that are not connected to a unit of prosodic space. Notice that we don't assume the floating nature to reside in a delinking process, as under (18)a. The deactivation is hosted in the nature of the grid point, as in (18)b. The model-theoretical reason is that we want the nature of the grid point to be shared by both tiers, i.e. it is a source of interaction between the tiers: the elements on both tiers are floating, (18)c. It is the more restrictive option in a model with two tiers. There is also a principled reason: it opens the possibility to consider association lines be part of the productive phonological calculus, while the nature of the grid point belongs to its lexical specification.

Elements are associated to grid points according to alignment, which operate Edge-In (Yip 1982), i.e. from the affix inward. In the cases we consider here, it will be right-to-left. Finally, we assume that only the element that is fully feature-depleted, |@|, may stand on a deactivated grid point, provided that it is licensed, (see below). This is represented in (17)h. A deactivated grid point is a weak position that resists host elements that are phonological complex, only dependent elements (Walker 2011).

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10 Cf. Yearley 1995, Grabinova & Harizanov (2016). The parallel with Slavic yers is attractive. See also section 6. A discussion of yers is outside the scope of this paper.
Element Theory (ET) adopts a calculus of elements which is basically standard set theory. Segments are *sets* of elements. We here elaborate an implementation of the place features in ET as a (semi)-lattice, i.e. we implement it along the lines followed by Harbour (2014)'s theory of the number features. We assume that elements in ET do not constitute the sounds themselves but are *(place) operators* working on grid points, thus producing a grid point with segmental exponence. For instance, the element \(|U|\) working on a grid point \(\cdot\), is assumed to produce \([u]\). We use the standard notation \(\cdot — |U|\). Similarly, \(|l|\) and \(|A|\), produce \([i]\) and \([a]\), respectively, when working on a grid point. \(|A|\) and \(|l|\) working together on \(\cdot\) produces \([e]\), etc. The sound \([e]\) is, hence, more complex than \([i]\) or \([a]\), which consist of only one element, while \([\text{o}e]\) is the most complex of all vowels. Element composition forms a bounded *join semi-lattice*. We define both JOIN (or "union") and MEET (or "intersection") as the two connectors working on this lattice. In the standard (and most simple) realization of this group, JOIN (+) and MEET (.) are commutative and associative. JOIN has a neutral element @, as in (19)-(20).

\[
\begin{align*}
\text{(19) a. } & \quad X + Y = Y + X, \\
\text{b. } & \quad X + @ = X, \\
\text{(20) a. } & \quad X . Y = Y . X \quad (= @ \text{ iff } X\neq Y) \\
\text{b. } & \quad X . @ = @ . X = @
\end{align*}
\]

All operations are idempotent, which means that applying once has the same result as applying more times: \(P^n = P\). As said, these elements form a mathematical pattern that is called a *lattice* (Partee, Van der Meulen & Wall 1990). The lattice structure can be (incompletely) represented in a Hasse diagram, given under (21)a and its exponence counterpart in (21)b.

\[
\begin{align*}
\text{(21) a. } & \quad \includegraphics[width=0.4\textwidth]{diagram1} \\
\text{b. } & \quad \includegraphics[width=0.4\textwidth]{diagram2}
\end{align*}
\]

When one goes up along the drawn lines, one follows the JOIN connector, for instance, the joint of \(|A|\) and \(|I|\), i.e. \(|A| + |I| = |A+I|\), illustrated by the red arrows under (22)a. When one goes
down, one follows the meet connector, e.g. MEET of \(|A+I|\) and \(|U+I|\) is \(|I|\), i.e. \(|A+I| \cdot |U+I| = |I|\), illustrated under (22)b.

\[(22) \quad \begin{align*} 
&\text{a.} \quad |A+I+U| \\
&|A+I| \quad |A+U| \quad |I+U| \\
&|A| \quad |I| \quad |U| \\
&\quad |@| \\
&\text{b.} \quad |A+I+U| \\
&|A+I| \quad |A+U| \quad |I+U| \\
&|A| \quad |I| \quad |U| \\
&\quad |@| 
\end{align*}\]

Going up increases complexity, going down reduces complexity. Disjoint sets produce \(\@\) under MEET, e.g. \(|A| \cdot |U| = |\@|\). Similarly, \(|A+I| \cdot |U| = |\@|\) (not represented in the Hasse diagram above). Random application of JOIN, i.e. \(|X|+|Y|\) (ultimately) produces the top node. Random application of MEET, i.e. \(|X|,|Y|\) (ultimately) produces the bottom node \(|\@|\). Without the element \(|\@|\), the set of elements would not be a bounded lattice under MEET.

There is a well-known relation between stress and vowel complexity, in the sense that stress tend to require complex segments, and simple segments require less stress (Trubetzkoy 1969, Dresher & Van der Hulst 1998: 322). Although this may be the result of historical processes, not a requirement of the synchronic grammar, schwa has synchronic requirements on the phonological structure it sits in. It does not sit under the stress, but leans on a stressed syllable, i.e. it is in the weaker part of a foot. We capture this dependency ("stress-bound-without-being-under-the-stress"), by \(|\@|\)'s being stress-licensed. A formal definition is given under (23). It captures the fact that schwa is parasitic on another stressed syllable: \(|\@|\) is either spreading/moving to it when it is in the same phase (in the sense of Lowenstamm 2010, Enguehard 2016), or, it can stay on its own if it is adjacent to the stressed syllable. Adjacency depends on linearity, which is only provided upon closure of the phase. Adjacency is therefore defined in relation to a phase domain, i.e. when it is in another morphosyntactic phase than the stress.
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(23) Schwa Licensing.
   \( [\ddagger] \) is licensed iff \( [\ddagger] \) is spreading to the stress or is adjacent to the stress. Licensing by adjacency operates when stress and schwa are in different phases (in the sense of Lowenstamm). \(^{11}\)

The first way to establish licensing typically occurs with strong verbs (whose root is not a phase), the second way is with weak verbs (whose stem is a phase, cf. section 5.5).

We further have to define in the model when the two operations MEET and JOIN operate. We assume a deterministic model where the structure defines which operation is active. On the V2-tier, elements are in competition with each other i.e. they do not operate on each other on the place lattice: one expulses the other. The competitive nature of the V2-tier implies that JOIN and MEET must both operate on the V1-tier. We assume that they operate in function of stress.

Taking into account the relation between on stress and complexity and the relation between destressing and neutralization (Trubetsky 1969), we adopt (24)-(25).

\[
\begin{align*}
\text{(24) V2 tier} & \quad \text{+stress} \\
& \quad \cdot + \rightarrow \cdot \\
& \quad \text{JOIN} \\
\text{V1 tier} & \quad |X| \quad |Y| \quad |X+Y| \\
\text{(25) V2 tier} & \quad \text{–stress} \\
& \quad \cdot + \rightarrow \cdot \\
& \quad \text{MEET} \\
\text{V1 tier} & \quad |X| \quad |Y| \quad |X.Y| \\
\end{align*}
\]

For the sake of completeness, we repeat under (26) how alignment proceeds from left to right, first the anchoring the floating \( |Y| \), while \( |X| \) remains without prosodic space. \( |X| \) is not deleted or overwritten but remains without exponent. Competition is limited to the V2-tier in our model (but see the discussion in section 10).

\[
\begin{align*}
\text{(26) V2 tier} & \quad \text{COMPETITION} \\
& \quad |X| \quad |Y| \quad |X| \quad |Y| \\
& \quad \cdot + \rightarrow \cdot \\
& \quad \text{COMPETITION} \\
\text{V1 tier} & \quad \ldots \quad \ldots \quad \ldots
\end{align*}
\]

\(^{11}\) An empirical and theoretical underpining of the relation between stress and the strong/weak opposition in verbs is given in Postma (2002:236-239).
We adopt a procedure of *Tier Conflation* (TC) upon spellout (McCarthy 1986) or, in more modern formulations at the closure of a phase (Lowenstamm 2010, Creemers, Don & Fenger 2016). Logically, there are two possibilities: conflation towards the V1-tier or conflation towards the V2-tier. The former possibility, conflation to the V1-tier, leads to coalescent forms. This is represented under (27). Fully in line with (24)-(25), we leave it as a function of the stress whether it is MEET or JOIN that instantiates the conflation operation.

\[
\begin{array}{c|c|c|c|}
\text{V2 tier} & \text{+stress} & \text{–stress} & \text{Tier Conflation 1 (TC)} \\
\hline
|X| & |TC1| & \cdot \rightarrow \cdot & \text{or} & \cdot \\
|Y| & |X+Y| & |X\cdot Y| \\
\end{array}
\]

Tier Conflation to the V2-tier leads to broken forms and, potentially, to expulsion effects. This relation between melodic complexity and length is not the object of study in this paper (it is briefly discussed in section 10). For the sake of completeness we give the representation under (28). This strategy is probably followed upon past tense formation (ablaut).

\[
\begin{array}{c|c|c|c|}
\text{V2 tier} & \text{TC2} & \text{V1 tier} & \text{Tier Conflation 2 (TC2)} \\
|X| & |Y| & |X| & |
\cdot \rightarrow \cdot & \cdot & |
\end{array}
\]

We symbolize the umlaut factor with *fraktur* character $\exists$, and assume a structure as under (29), which includes a floating umlaut factor $|I|$ on the V2-tier and $|@|$ on the V1-tier. The empirical justification is postponed to section 5.3.

\[
\begin{array}{c|c|c|c|}
\text{23sg suffix $\exists+(s)t$ in German}^{12} & \text{Imperative morpheme in German} \\
\text{V2-tier} & |I| & |\@| & |
\end{array}
\]

We follow Leben (1973), Goldsmith (1976), McCarthy (1978) and assume the Obligatory Contour Principle (OCP), which penalizes two adjacent identical elements on one tier, and

\[12\text{ This assumption in combination with the two tiers generates various types of umlaut: any single step vowel change in the Hasse diagram above that does not make the root vowel lower or more back. Vacuous umlaut is generated too, apart from in the dashed plane in the cube in (21)a.}\]
provides a resolution at the same time, given under (30). Notice that we take the OCP to be defined on the V2-tier (it may not work on the V1-tier because of the idempotence of JOIN and MEET) and, hence, must be defined in function of at least one grid point. The requirement on the second grid point is underspecified for • or •.

\[(30) \quad \begin{array}{c|c|c}
\text{V2 tier} & \text{OCP resolution} \\
\hline
|X| & |X| & [X]
\end{array}
\]

This closes off our exposition of the model.

To help the reader with the interpretation of the novel competitive V2-tier\(^\text{13}\), the reader may think of the V2-tier as a layer of representation that hosts articulatory properties of vowels shared by vowels and sonorants \{n, lr, m\}. While vowels and consonants occupy different autosegmental tiers and are supposed not to interact before tier conflation, their subarticulation may interact on the V2-tier before tier conflation. The reader may think of the approximant, or glidal, or semi-vocalic (sub-)properties.\(^\text{14}\) The V2-tier hosts (place features of underlying) glides that realize vocalically when anchored to a vocalic grid point, and consonantally as /w/j/ (=|U| and |I|), /r/l/ (=|A|) and /n/ anchored to a consonantal grid point. As to /n/, it is a sonorant without place features, i.e. |@| apart from its laryngeal and manner features (nasality). In this autosegmental interpretation, the V2-tier is the articulatory layer where vowel-vowel interactions and consonant-vowel interactions take place. This interpretation does not have a theoretical status (yet) nor has it been of any guidance for the development of the model. It is a helpful interpretive background, though. In Postma 2016, it is argued that this V2-tier has "consonantal" properties undergoes a consonantal type of ablaut despite being on a vocalic grid point.

In the next sections we apply competition and coalescence of elements to capture alternating verbs, the imperative conundrum, and epenthesis conundrum, in a formal fashion.

\(^{13}\) A similar proposal, though different in details and predictions, is presented in Faust & Brandão de Carvalho (2017). It predicts only expulsion effects with |A|. It disallows for expulsion of |U| in (6).

\(^{14}\) In Postma 2014, a layer was identified with "consonantal ablaut": A-I-A and A-U-A. That layer is probably identical to the V2-tier of this study.
5 Application of the model

5.1 Alternating verbal paradigms

In this section, we apply the model developed above to the problem of the alternating verbal paradigms, i.e. vowel alternation in the strong verb class present tense. It explains the alternation such as *ich schlaf* - er *schläft* 'I/you sleep', and *ich helfe* - er *hilft* 'I/he helps'. After our preparatory work, the calculus is rather straightforward. The representations of the two verbs become as under (31) - (32). Upon morphological concatenation of root and defective 23sg suffix, realignment takes place. The scheme ignores vowel length, which will be discussed in section 7.

\[
\begin{align*}
(31) & \quad \text{V2 tier} & \quad |I| & \quad |I| \\
& \quad \text{schl} \cdot f + t & \rightarrow & \quad \text{schl} \cdot f t \\
& \quad \text{schlaf} + \text{t} & \rightarrow & \quad \text{schläft} \\
& \quad \text{V1 tier} & \quad |A| & \quad |@| & \quad |A+@| = |A|
\end{align*}
\]

In the case of *helfen*, the root lexicalizes both the V1-tier and the V2-tier because of the historical A-umlaut, cf. (14).

\[
\begin{align*}
(32) & \quad \text{V2 tier} & \quad |A| & \quad |I| & \quad |A| & \quad |I| \\
& \quad h \cdot l \ f + t & \rightarrow & \quad h \cdot l f t \\
& \quad \text{helf} + \text{t} & \rightarrow & \quad \text{hilft} \\
& \quad \text{V1 tier} & \quad |I| & \quad |@| & \quad |I+@| = |I|
\end{align*}
\]

Some comments are in place. Under (31) we have the more simple I-umlaut. This I-umlaut comes about by adding a floating I-element in the 23sg of the present tense by some morphological (inflectional) procedure. We assume |I| is on the V2-tier, which is competitive, but this property is not really active in the case of *schlafen* 'sleep' and *raten* 'guess', as the root's V2-tier is empty. The floating I-element, which does not have a grid point of its own, anchors to the (stressed) stem but stays on its own tier. The result is an alternating stem vowel [a] to [ɛ]. The |@| element on the V1-tier coalesces with the material present.

Let us now look at the more challenging case of *helfen* 'help', a verb with had, historically, A-umlaut. As we have seen from the introduction, these verbs have generalized an A-element that used to be part of the ending. This |A| has become part of the root (producing *geholfen*) but this (originally suffixal) A-element has not changed its V2-tier nature. We then have the structure in (32). Now, consider what happens if we add the same suffixal floating I-element of 23sg present tense. As it is a V2-tier element, and since V2-tier elements compete, the
anchoring of the suffixal |I| to the stem and upon right-to-left alignment, pushes out the A-element. As a result, we get a seemingly subtractive effect, although it comes about by a normal additive procedure with the standard floating I-suffix. The A-subtraction is a kind of stray erasure effect (Steriade 1982). This generalizes over the two paradigms in (16). Notice that (31) is in line with the rather standard assumption that umlaut is a floating coronal feature that it must spread to the stem (Hermans & Van Oostendorp 2008, Trommer 2010).

5.2 Application to the Imperative Conundrum

Let us now apply the model to the Imperative Conundrum, given in (9), repeated here as (33).

(33) Imperative Conundrum
• Alternating verbs have the non-23 stem as imperative if the infinitive has /a/a:/au/ in the stem, + optional schwa: schlaf(e), rat(e), lad(e), lauf(e), etc.
• Alternating verbs have the 23 stem as imperative if it has /e/e:/ in the stem, + no schwa: gib, nimm, sieh, ficht, tritt, etc.
• Non-alternating verbs have the stem + schwa as the sg imperative: spare!, denke!, spiele!, etc.

This riddle concerns the choice of the ending and the choice of the root vowel. From a historical point of view, the shape of the stem is perfectly understandable: the imperative takes the verbal bare root + imperative suffix, i.e. it lacks both the suffixal I-element in the rate-rätst-rät class, resulting in rat!, and it lacks the (originally suffixal) A-element in helfen, resulting in hilf! So, from an historical perspective, there is no conundrum. However, as we have seen above, the synchronic situation is that this |A|-element is part of the root for the present-day native speaker. And secondly, we have seen in section 5.1 that the alternating verbs do not come about by A-umlaut, but by adding a floating |I|-element, just as in the case of the I-umlauting verbs, which expels |A|. So, we are looking for a synchronic account.

Our model developed in the previous pages provides a way to see the imperative forms as being produced by a synchronic, productive, regular process. In order to get the desirable results, we only have to assume an imperative morpheme that sits on the V2 tier (as it is a suffix). Since the German imperative morpheme is schwa in regular verbs (spielen/spiele! 'play.inf/play.imp'), let us assume it is schwa in strong verbs as well. Let us see what happens when a floating imperatival schwa is added. In (34)-(35) we represented the alignment strategy of root and floating suffix.
For /a/-stem verbs such as *raten 'guess' and *schlafen 'sleep', etc, |@| simply realizes on the V2-tier of the verbal root. No element is present on this tier and so, there is no problem in this case.

The more interesting case is the A-umlauted verbs. As this |A| is synchronically part of the stem as a V2-tier vowel, it goes in direct competition with |@|. Upon right-to-left alignment, the |A| remains without anchoring, it is driven out by the imperative-schwa, as it were. *Hilf! results.

In (36)-(37), we analyze the variants with spreading of |@|, *schlaf! and *gibe. The spread variant, though slightly stilted in modern German, is without problem in the case of *raten, because there is no element on the V2-tier. In the A-umlauted class, spreading is simply not invoked upon right-to-left alignment as it is a last resort (McCarthy 1979) because two elements are present (|A| and |@|) and two grid points. Moreover, the result would be ill-formed because one grid point is occupied with two V2-tier elements. These spread variants are indeed absent: *hilfe!15 'help.imp', *gibe! 'give.imp', *tritte! 'step.imp'.

15 Though possible as a noun: *Hilfe.
This solves the imperative conundrum.

Notice that the system allows for a combination of the strategies in (36) and (37)b with a double |A| on V1- and V2-tier, as in (38).

\[(38)\]
\[
\begin{align*}
\text{a. V2 tier} & \quad |\text{A}| & |\text{A}| & \text{spread} \\
& \quad |\text{A}| & |\text{A}| \\
1 \cdot \text{ss} & + \quad \rightarrow & 1 \cdot \text{ss} & \quad \text{lass}+\text{ə} \rightarrow \text{*lasse!} \\
\text{V1 tier} & \quad |\text{A}| & |\text{A}| \\
\text{b. V2 tier} & \quad |\text{A}| & |\text{A}| & \text{align} \\
& \quad |\text{A}| & |\text{A}| \\
1 \cdot \text{ss} & + \quad \rightarrow & 1 \cdot \text{ss} & \quad \text{lass}+\text{ə} \rightarrow \text{lasse!} \\
\text{V1 tier} & \quad |\text{A}| & |\text{A}| \\
\end{align*}
\]

This option is realized in the verb *lassen* 'let' (and *fallen* 'fall' for some speakers), which is an alternating verb of the i-umlaut type (*lassen-lässt*) but also lacks the option of schwa in the imperative (lass!/*lasse!*). It is evidence that a double |A| element is present on both V1 tier and V2 tier in *lassen* 'let'.

5.3 Application to the Epenthesis Conundrum

Before we apply the theory to the epenthesis conundrum, let us first give an an empirical justification to our representation of the umlaut factor in (29). We take our evidence from West-Germanic dialectology. Notice first that Dutch, Frisian, Pomeranian, the Low-Saxon and Limburgian dialects in the Netherlands do not have epenthetic vowels in the contexts under scrutiny at all, and resolve the -t+t-clash by degemination or — as happens in the Low Saxon dialects of Twente — simply have a "thick T" in this context (Van der Velde 1994:70). Dutch does not have umlauted 23sg forms, but Pomeranian, Low Saxon, and Limburgian do exhibit vowel alternation but do not show epenthesis. Frisian has sometimes alternating forms in 23sg (*ik meitsje-du makkest-hy makket 'I/you/he make(s)'), but no morphological umlaut. Moreover, Frisian schwa between root and ending is a property of a separate verbal class (the so-called je-
verbs), not a phonological effect. Hence we listed Frisian in the [-epenthesis, -umlaut] class together with Dutch. Finally, I added Yiddish which lost both umlaut in 23sg present tense and epenthesis (Albright 2006).

(39) **Dialectology of epenthetic schwa in 23sg present tense in West Germanic**

<table>
<thead>
<tr>
<th>Dialect Chart</th>
<th>+ epenthesis</th>
<th>- epenthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ I-umlaut</td>
<td>High German</td>
<td>Pomeranian</td>
</tr>
<tr>
<td></td>
<td>Low German</td>
<td>Low Saxon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limburgian</td>
</tr>
<tr>
<td>- I-umlaut</td>
<td>Dutch</td>
<td>Frisian</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yiddish</td>
</tr>
</tbody>
</table>

The chart under (39) shows that epenthetic schwa comes about in a subset of the languages with i-umlauting forms in 23sg present tense. In languages without I-umlaut in 23sg, epenthetic schwa is absent. This shows that schwa-epenthesis is dependent on 23-umlaut in the language despite the fact that epenthesis does not show up precisely when 23-umlaut applies in a specific verb. This can be explained by assuming that, synchronically, schwa epenthesis lexicalizes the vocalic slot in a 2/3sg morpheme, i.e. здрав, unless the melody has incorporated into the verbal stem upon umlaut. It suggests the structural identity of umlaut and schwa epenthesis. This suggests the element theoretical implementation of umlaut in the Competitive Tier Model: a floating |@| on the V1-tier with an |I|-coloring on the V2-tier, cf. (40).

(40) **Umlaut suffix здрав in High and Low German**

```
V2-tier       | I |
             |   |
             |   |
V1-tier       | @ |
```

Now, one might be tempted to formulate epenthesis as a rule under (41), which activates the grid point.

(41) **Epenthesis (rejected)**

```
V2-tier       | I | I |
             |   |   |
             |   |   |
             |   | → |
V1-tier       | @ | @ |
```
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However, this cannot be correct because it would provide [I] with prosodic space and removes its floating nature. Instead, we retain the deactivated grid point and make the assumption that epenthesis is not an independent process, but is simply tier conflation, defined under (27) and applied to umlaut under (42).

(42) Epenthesis = tier conflation operating on a deactivated grid point

<table>
<thead>
<tr>
<th>Tier Conflation</th>
<th>–stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2 tier</td>
<td>[I]</td>
</tr>
<tr>
<td></td>
<td>[I]</td>
</tr>
<tr>
<td></td>
<td>MEET</td>
</tr>
<tr>
<td>V1 tier</td>
<td>[@]</td>
</tr>
<tr>
<td></td>
<td>[I]</td>
</tr>
<tr>
<td></td>
<td>@</td>
</tr>
</tbody>
</table>

We now apply the phonetic spellout rules in (43).

(43) a. Spell Out Rule for High/Low German

X • (s)Y is spelled out as [X ø(s)X]iff X ⊆ Y, else as [XY] 16

|       |
| [@]  |

b. Spell Out Rule for Pomeranian, Low Saxon, and Limburgian

X • (s)Y is spelled out as [XY]

|       |
| [@]  |

In other words, High and Low German on the one hand, and Pomeranian, Low Saxon and Limburgian on the other hand, have the same underlying phonological representation, with umlaut being underlyingly present while they differ in their phonetics. Dutch and Frisian (and perhaps Yiddish) are underlyingly different from the German varieties because they do not have the umlaut configuration in 23sg and do not need these spellout rules.

As we have shown in section 1, both verbs with I-umlaut (raten 'guess' lassen 'let', and the verbs with A-umlaut (geben 'give', treten 'step', etc.) have the [I]-element in the ending, i.e. it is Ψ+t and Ψ+st. The representations are given under (44)-(46). The alignment structure is in (44).

16 This inclusion relation is needed to include d-t clashes. We assume /d/ is less specified than /t/ or d ⊆ t, i.e. final fortition in German instead of final devoicing. Notice that we get batet with [d] instead of batet. Absence of final fortition implies that a deactivated grid point projects a syllable. What this shows that a deactivated grid point is different from absence (I am grateful to an anonymous reviewer for drawing my attention to this point).
The spreading configuration is under (45). This produces an ill-formed structure as |I| may not sit on a deactivated grid point, cf.

\[(45)\]
\[
\begin{array}{c}
\text{V2 tier} \\
|I| \\
r \cdot t \rightarrow r \cdot t \rightarrow r \cdot t
\end{array}
\]
\[
\begin{array}{c}
\text{V1 tier} \\
|A| \\
|@|
\end{array}
\]

The structure would become (46) upon tier conflation.

\[(46)\]
\[
\begin{array}{c}
\text{V2 tier} \\
|I| \\
\text{TC} \\
|I|
\end{array}
\]
\[
\begin{array}{c}
\text{licens} \\
\text{r \cdot t} \rightarrow r \cdot t \rightarrow r \cdot t \\
\rightarrow \text{rat+}@ \rightarrow \text{rät}
\end{array}
\]
\[
\begin{array}{c}
\text{V1 tier} \\
|A| \\
|@| \\
|A| \\
|A| \\
|@|
\end{array}
\]

This structure is also ill-formed. The reason is that an epenthetic |@| is only licit on a deactivated grid point if it is licensed, i.e. situation (17)h. However, strong roots do not form a phase and adjacency is not defined. Only full alignment starting off at the first active grid point in (44) creates a well-formed structure.

Similar relations hold in the a-umlaut class. As we have seen, these have i-umlaut as well. |A| sits on the V2-tier while |I| sits on the V1-tier. The representations are under (47)-(49).

\[(47)\]
\[
\begin{array}{c}
\text{V2 tier} \\
|A| \\
|I| \\
|I|
\end{array}
\]
\[
\begin{array}{c}
\text{align} \\
|A| \\
|I|
\end{array}
\]
\[
\begin{array}{c}
\text{tr \cdot t} \rightarrow \text{tr \cdot t} \rightarrow \text{tr \cdot t} \\
\rightarrow \text{tret+}@ \rightarrow \text{tritt}
\end{array}
\]
\[
\begin{array}{c}
\text{V1 tier} \\
|I| \\
|@| \\
|I| \\
|@|
\end{array}
\]

Spreading is not possible, as represented under (48), because of a two-fold ungrammaticality: The structure violates the competition on the V2 tier. Furthermore, |I| may not sit on a deactivated grid point.
Let us finally discuss tier conflation. This process gives rise to the ungrammatical (49). As \textit{treten} is a strong verb, its root is not a phase. Hence licensing of schwa by adjacency is not possible (adjacency is not defined).

Notice that there is no conundrum in second person plural present tense. The forms are \textit{ratet} and \textit{tretet}. We only have to assume that the 2pl suffix has no umlaut factor, only \(|@| + \text{t}\) on a deactivated grid point on the V1 tier. The analysis for \textit{tretet} is given under (50). The analyses for \textit{ratet} 'you.pl guess', as well for non-epenthetic forms such as \textit{spielt} 'you.pl play' are mutatis mutandis.

This solves the epenthesis conundrum.

5.4 \textit{Strong verbs with epenthesis (bieten 'offer') – OCP effects}

Let us now observe a limited class of strong verbs that surprisingly have epenthesis in 23sg. These are typically verbs with [i] in the root, be they lax or tense monophthongs (\textit{bitten} 'request', \textit{bieten} 'offer'), diphthongs (\textit{leiten} [ai] 'lead'), or vowel nasal combinations (\textit{binden} 'bind', \textit{singen} 'sing'): they realize epenthetic (er) \textit{bittet/bietet/leidet/bindet} '(he) requests offers/leads/binds'. In these circumstances, there is an adjacent realization of two \(|I|\)-elements, one of the root and one of the suffix. So, we hypothesize that the OPC is at work. Comparative evidence for this is that heterorganic diphthongs [ai], [oi] and [ui] are unaffected by mutation in Pomeranian. One could
also say that already umlauted forms are not susceptible for a second umlaut cycle. Now, upon alignment and expulsion, the OCP violation is still there, as expulsion does not delete an element but prevents it from exponence. So the OCP violation is still present. On the other hand, the context of the OCP resolution (30) is lost. The structures are drawn under (51)-(52).

(51) biet-  ₛt  align  biedt  *OCP  *biedt  
V2-tier  \[|I|  \|I|  \|I|  \|I|  \|I|  \|I|\]  
\[b \cdot t + ₛt \rightarrow b \cdot t ₛt \rightarrow b \cdot t ₛt\]  
V1-tier  -  [@]  [@]  [@]  

While alignment gives rise to ill-formedness *biet, spreading is possible. As the context of OCP conversion is present, |I| is deleted, and we are only left with spreading |@|, which is licit: betet. When the OCP works in situ with spreading, the structure becomes well-formed.

(52) biet-  ₛt  OCP  biet  spread  biet  
V2-tier  \[|I|  \|I|  \|I|  \|I|\]  
\[b \cdot t + ₛt \rightarrow b \cdot t ₛt \rightarrow b \cdot t ₛt\]  
V1-tier  -  [@]  [@]  [@]  

As to the epenthetic schwa, the V1-tier is completely empty and the |@| element can spread to the root for licensing. Similar results are obtained with leiden 'lead', either pronounced as [ai] or [ei]. This root with [ai] has been analyzed under (53)-(54). The [ei] dialect have an extra |I|-element on the V1-tier.  

(53) leid-  ₛt  align  *OCP  *liidt  
V2-tier  \[|A|  \|I|  \|I|  \|A|  \|I|  \|I|\]  
\[l \cdot d + ₛt \rightarrow l \cdot d ₛt \rightarrow l \cdot d ₛt\]  
V1-tier  [@]  [@]  [@]  

17 A problem looms upon including ablaut into this system, in view of the expulsion of |A| (± shortening) upon past tense formation [ai] \[→ [i(:)]\]: meiden-m[iː]d 'avoid(ed)', leiden-litt 'suffer(ed)'. |A|'s expulsion might come about by |@| rather than |I|. See also the discussion in section 10.
5.5 Weak verbs

Weak verbs form their past tense by suffixation, e.g. in German –te: wahlen-wahlte-gewahlt 'choose'. Moreover, they seem to have a deviant 23 sg suffixation: they do not have umlaut, only the suffixal -(s)t survives in 23sg.: er wahlت/*wählт. Furthermore, they always have epenthesis upon root-suffix clashes: er spaltet 'he splits'. Finally, they realize the imperative in –e: spalte! The competitive tier model predicts all these deviant facts without further stipulation.

Most weak verbs are denominal, i.e. their stems are not formed by bare roots but by a derivational head. They are, therefore, phases (Lowenstamm 2010, Creemers, Don & Fenger. 2015). Let us assume that weak verbs are all derivational stems (root+F). This means that schwas in suffixes cannot and do not need to spread to the stressed stem, but are licensed in situ under adjacency, cf. (23). Moreover, the root vowels are all on the V1-tier, because the stem has already undergone tier conflation at the phase level. Under (55) and (56) we give the analysis for the imperative suffix |@|→• and the 3rd person singular present tense suffix -stile, i.e. |@|→•→|I|+t.

Let us start analyzing the imperative. Spreading of |@| to the stem is unproblematic. Staying in situ is licit, as the stem is a phase. Tier conflation is licit as well. We actually think that the latter analysis is the only correct one, which is given under (55).

$$\begin{align*}
(54) \text{ V2-tier} & \quad |A| & |I| & |I| & |A| & |I| \\
\quad \quad |A| & |I| & |I| & |I| & |A| & |I| \\
\text{leid-} & \quad \text{stile} & \quad \text{OCP} & \quad \text{leidet} \\
\text{V1-tier} & \quad |@| & |@| & |@| & |@| & |@| \\
\text{This shows that this strong class with epenthesis is allowed by the model.}
\end{align*}$$

$$\begin{align*}
(55) \text{ V2 tier} & \quad |@| & \text{TC} \\
\quad \quad w \cdot hl & \quad \Rightarrow & \quad w \cdot hl & \Rightarrow & \quad \text{wahl+ə} & \quad \rightarrow \text{walhle!} \\
\text{V1 tier} & \quad |A| & |@| \\
\end{align*}$$

At first glance, spreading of |@| to the stem seems to be licit because there is no material present on the V2-tier tier. However, spreading to the stress is redundant because the schwa is already

---

18 For a uniform treated of suffixal –te and ablaut, cf. Postma 1997, 2014, where it is argued that –te is the consonantal realization of floating |I|. 
licensed in situ because of adjacency as /wahl-/ is a phase. Spreading to the stem, being a phase, is even forbidden. This makes (55) with tier conflation the only possible analysis.

The 3rd person suffix is parallel. Alignment is not possible because the stem of weak verbs is a phase. Spreading is not possible, because |l| may not sit on a deactivated grid point. Staying in situ is illicit because |l| cannot sit on a deactivated grid point (*spaltit). Tier conflation is the only option.

\[
\begin{array}{cccc}
\text{spalt-} & \text{-t} & \text{TC} & \text{spaltet} \\
\text{V2-tier} & |l| & |l| \\
\text{sp} \cdot \text{lt} + \text{-t} & \rightarrow & \text{sp} \cdot \text{lt} + \text{-t} & \rightarrow & \text{sp} \cdot \text{lt} + \text{-t} \\
\text{V1-tier} & A & |@| & |A| & |L.@|=|@| & |A| & |@| \\
\end{array}
\]

TC gives us just |@| on the V1-tier (under MEET), which is licit on a deactivated grid point if licensed. This is the case, as |@| is adjacent to the stem because the stem of a weak verb is a phase. An attractive feature of our model is that it generalizes over strong and weak verbs. They have the same underlying endings in the present tense, though their realization is quite different. This solves the epenthesis conundrum by means of the competitive V2-tier model.

5.6 The -jan class ("rückumlaut")

There is a class of verbs in German with past tense stem vowel change (brenn-/brann- 'burn', nenn-/nann- 'mention', renn-/rann- 'run', denk-dacht- 'think', ...), that belongs to the epenthetic category. These stems typically have /e+/n/ in the root.19 This class includes two stems that end in a dental plosive: send-/sand- 'send' and wend-/wand- 'turn', which can serve as a testing ground for epenthetic behaviour: they have epenthetic schwa: sende/sendet and wende/wendet. The question is how these verbs work. Now, these verbs belong to a class that underwent the rückumlaut. Rückumlaut happened in verbs that made the present tense with -jan. This /j/ glide in the suffix caused two changes. The glide's (floating) |l| caused umlaut of the present tense stem and its consonantal nature caused gemination of the final root consonant (Vennemann 1986). Because of this historic rückumlaut, and to make a contrast to the verbs like treten, geben, nehmen, let us explore the natural hypothesis that these root verbs have their |l| element on the V2-tier and |A| on the V1-tier.

19 The rückumlaut class was bigger in Middle High German (smeck-/smac- 'taste', setz-/satx- 'put', hör-/hör- 'hear', wÜrk-/worh- 'work'), but /n/ roots are the only that survived in Standard German. See also section 8 on the special status of /n/ vis-à-vis /t/ and /l/.
Let us first consider what happens under alignment. |I| expels the |I| element but then the OCP blocks this structure whereas the context of OCP resolution is lost. So the OCP clash cannot be resolved under alignment. The configuration is given under (57) and predicts the result *sendt to be ill-formed. This is a correct prediction.²⁰

\[
\begin{align*}
(57) & \quad \text{send-} & -\text{3t} & \quad \text{sendt} & \quad *\text{sendt} \\
V2\text{-tier} & \quad |I| & |I| & \text{align} & |I| & |I| & \text{*OCP} & |I| & |I| \\
& & s \cdot n d + t & \rightarrow & s \cdot n d + t & \rightarrow & s \cdot n d + t \\
V1\text{-tier} & |A| & |@| & |A+@| & |A+@| & |A+@| & |A+@| & |A+@|
\end{align*}
\]

The \textit{in situ} analysis + spreading is in (58). In this case the OPC reduces the double occurrence of |I|. This neutralizes the violation of |I| sitting on a deactivated grid point. The schwa can be licensed under spreading to the stress. The spreading strategy, which produces the existing sendet, is therefore predicted to be well-formed.

\[
\begin{align*}
(58) & \quad \text{send-} & -\text{3t} & \quad \text{sendet} \\
V2\text{-tier} & \quad |I| & |I| & \text{OCP} & |I| & \text{spread} & |I| \\
& & s \cdot n d + t & \rightarrow & s \cdot n d + t & \rightarrow & s \cdot n d + t \\
V1\text{-tier} & |A| & |@| & |A| & |@| & |A| & |@|
\end{align*}
\]

Let us finally check tier conflation. Inspect the structure under (59).

\[
\begin{align*}
(59) & \quad \text{send-} & -\text{3t} & \text{TC} & +\text{stress} & -\text{stress} & \text{sendet} \\
V2\text{-tier} & \quad |I| & |I| \\
& & s \cdot n d + t & \rightarrow & s \cdot n d + t & \rightarrow & s \cdot n d + t \\
V1\text{-tier} & |A| & |@| & |A+I| & |@I| & |A+I| & |@|
\end{align*}
\]

The theory predicts (59) to be well-formed if and only if the stem licenses the epenthetic schwa in situ. Interestingly, these verbs do not only display vowel change, they are suffixal as well, i.e. they are both strong and weak: \textit{senden-sandte-gesandt}. Being weak, the root is a phase because of (23), and can license the schwa in the suffix under adjacency.²¹ So, |@| is licensed

²⁰ This is a strong argument that competition is not \textit{overwriting} but \textit{expulsion}, as the OCP violations of expelled elements remain active.
²¹ A domain can, obviously, not be a phase and not a phase. This implies an extra head, which is either zero, or coincides with part of the stem, say, that \textit{sen-} is the root and \textit{send-} the weak stem.
without spreading to the root. This shows that the model predicts *sendet*, more specifically, two underlying representations of it: one that is well-formed when */send-* is strong, and one that is well-formed when */send-* is weak. We would like to decide which structure *sendet* has: the spreading strategy of *bindet*, or the analysis with tier conflation of the weak verbs.

Now, all the verbs in this -*jan* class were lost in Modern German, unless they had */n/ in the coda. If this */n/ is alone in the cluster, it is dropped in the past tense: e.g. *denken-dacht*, but when it is part of an historic geminate it is retained. Now, */n/, in contrast to */lrm…/* has no place features, i.e. it is |N|, (i.e. |@| on a C-slot). So let us assume that the */n/ in these verbs have |N|=|@| on the V2-tier.

\[
\begin{array}{cccccc}
\text{send-} & -3t & \text{TC} & +\text{stress} & -\text{stress} & \text{sendet} \\
\text{V2-tier} & |I| [N] |I| \\
 & s \cdot n \cdot d + t \rightarrow s \cdot n \cdot d \rightarrow s \cdot n \cdot d & t \\
\text{V1-tier} & |A| [@] |A+I| [N] [A.I] |A+I| [A] [@] \\
\end{array}
\]

This has as a consequence that the OCP does not apply. Moreover, the umlaut factor would cause its expulsion, but the fact that |N| is part of a consonantal cluster or geminate resists this. To solve this clash, in situ spellout of the umlaut factor is the only option. This is only possible upon tier conflation: *senden-sendt-gesandt* must be a weak verb.

6 The reality of the expelled element: interaction with prefixes

There is an apparent exception to the mono-valued nature of each grid point on the V2-tier: the German verb *erlöschen* 'to be extinct'. It shows an I-A-U ablaut sequence on the V1 tier and a complex "parasitic element" |A|—|U| on the V2-tier. It suggests that the V2-tier may host a complex object, composed of two elements.

\[
\begin{array}{cccc}
\text{erlöschen} & \text{erlosch} & \text{erloschen} \\
\text{V2-tier} & |A+U| & |A+U| & |A+U| \\
 & ɛrl • ʃ  & 1 • ʃ & ɛrl • ʃən \\
\text{V1-tier} & |I| & |A| & |U| \\
\end{array}
\]

This complex |A+U| on the V2-tier, however, behaves like a single element upon I-umlaut in 23sg present tense, giving rise to *erlischt* 'he is extinct', as represented under (62).
This verb, therefore, violates the calculus permitted in the V2-tier formalism. Notice, however, that the ablauting nature of this verb is dependent on the presence of the er-prefix: the verb without the particle, löschen 'extinguish', is not apophonic and not alternating. Moreover, it is causative. In similar causative pairs, where the base is apophonic and its causative derivative is weak, like s[i]zen→s[e]zen 'sit/set', l[i:]gen→l[e:]gen 'lie/lay', dr[i]nken→dr[e]nken 'drink/cause to drink', the causative morpheme is realized by adding |A| to the root. In the case of erlöschen→löschen there is not such a stem opposition: one would rather expect lüschen→löschen, not erlöschen→löschen. This makes it probable that the |A| element in the stem erlösch- is only parasitically there: it may parasitic of the |A| element in the prefix er-. If so, the umlauted form erlischt falls into place. The full representation is given under (63).

Observe that the expelled |U| intervenes between prefix and root and prevents V1-tier spreading of |A|. The loss of |A|, therefore, does not come about upon direct expulsion but upon blocking of |A|-spreading (Edge-In) from the prefix. This reduces our exception to a standard competitive effect on the V2-tier. The configurational blocking of |A|-spreading shows the reality of the expelled |U| element in the underlying representation, despite its lack of exponence in erlischt: without the intervening silent |U| we would predict erläscht.

---

22 I thank Tobias Scheer for drawing my attention to this.
23 Cf. Gothic lithan 'go' and laidjan 'lead', which adds a left aligned |A|. Causative morphemes are sometimes suffixal (e.g Eng. to redden), sometimes prefixal (Eng. to enlarge).
24 A reviewer asks the legitimate question how the expelled |U| can possibly be an intervenor since it is on another tier. The correct question is rather: how does the spreading from prefix to root survive tier conflation upon spellout. We do not know it. We can only say that the relation between a prefix and the stressed root is easily disrupted (Van Oostendorp 2004).
The V2-tier analysis + prefix interaction also provides the structure of German modal verbs, such as mögen-mag’(he) may’ and können-kann ’(he) can', with a similar interaction between expelled element and a prefix, cf. (64).

(64) kannen-kannst-kann 'can' & mögen-magst-mag 'may'

<table>
<thead>
<tr>
<th>PFX</th>
<th>kön-</th>
<th>-e</th>
<th>PFX</th>
<th>kan</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2-tier</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(v)</td>
<td>m • g + (st)</td>
<td>v • r</td>
<td>m • g + (st)</td>
<td></td>
</tr>
<tr>
<td>V1-tier</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Evidence for (silent) presence of a prefix is the incompatibility of können and MHG sollen with overt prefixes (*be-/*er-/*ent-/*ge-/*ver-/*zer-können), and an optional dummy²⁵ prefix ver- in the case (ver)mögen-(ver)mag. Notice that these modal (so-called "present-preterit") verbs use the subjunctive endings -e/-est/-e. If the schwa in the ending is floating, it produces the kann-kannst-kann, while the anchored vowel produces the subjunctive paradigm: könne-könnest-körne.²⁶ Early Modern High German sollen-sal and Dutch zullen-zal could be analyzed as the same structure in (64), but probably the [I] and [U] elements are reversed, as under (65).

(65) Early Modern German sollen-sal and Dutch zullen-zal 'shall'

<table>
<thead>
<tr>
<th>PFX</th>
<th>soll-</th>
<th>-e</th>
<th>PFX</th>
<th>sal</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2-tier</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V1-tier</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Evidence for this reversal is coastal Dutch zelen-zal (with [@] prefix), and Pomeranian and English schåla/shall with consonantal realization of [U]-prefix²⁷ and expulsion of [I] on the V2-tier. The Old-Saxon onset alternation sculun – thu ni salt’(they) shall - thou NEG shalt’ confirms

²⁵ Grimm's Wörterbuch (1838-1961, s.v. vermögen): "vermögen: zusammensetzung mit dem präterito-präs. mugen, mögen (s. 6, 2449), dessen bedeutung durch die zusammensetzung nicht wesentlich beeinfluszt ist."

²⁶ This analysis of alternations in these so called "preterit presents" also carries over to parallel alternations in true preterits with alternations ("grammatischer Wechsel"), in MHG and (Middle) Dutch, captured diachronically in Verner's law.

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this pattern. The drop of /ch/ is, therefore, a consequence of intervening nature of expelled |l]. Standard German sollen-sol is regularized in the sense that the prefixal |U| on the V1 tier is now part of the stem, i.e. |U|—|A| on the V1 tier. A full account of the prefix interactions is outside the scope of this paper.

7 Application to vowel shortening

Thus far we ignored vowel length and vowel shortening in imperatives and 23sg forms. However, as we have seen in section 2.3, there is a riddle to be solved here. While verbs without vowel alternation never shorten, verbs with alternation show a mixed behaviour: verbs with e-i alternation show shortening, but verbs with a-e alternation do not. The long vowel [e:] in geben, nemen, treten shortens to [i] in gib!, nimm!, tritt!, as well as in 23sg present tense, e.g. (er) gibt, nimmt, tritt. In schlafen, raten, etc., however, which have a long root vowel [a:], no such shortening is observed, e.g. schläft, rät, etc. which has long [e:] or [e:]. The empirical generalization is under (66).

(66) • Alternating verbs of the a-i class have no shortening
• Alternating verbs of the e-i class have shortening

Apparently, shortening does not correlate with vowel change as such, but with element expulsion, viz. expulsion of an |A| in gib! etc. If there is element addition, as addition of |l| in schlafen-schläft, no shortening is observed.

(67) • Element addition does not lead to shortening
• Element expulsion leads to shortening

Apparently, the competitive tier model with subtraction and addition potentially makes the correct division line. Unfortunately, a mechanism cannot (yet) be formulated in the model, as a definition of length is still missing in our framework.

28 Cf. the Old Saxon Genesis 2, 77: forhuâtan sculun thi hlutra liudi,|thu ni salt io furður cuman te thînes hêrron sprâko. The proclitic negation ni might be the triggering factor in view of 2 times scalt thu. Schütze (1806: 56) on Holstein Low German gives: ik sall, du s(ch)ast, he s(ch)all - wi schölen, etc. with a sg-pl contrast.
29 Notice that Older German sōllen and Dutch zullen are defective for participle formation *gesōlt/Dutch *gezuld, while modern German gesolt is well-formed.
30 See note 6. We only discuss length here.
Even if the generalization in (67) is correct, vowel shortening cannot be too rigidly tied to element expulsion, because if the vowel is already short, like in *helfen* (35) or *lassen* 'let' (38), expulsion of |A| does not lead to ungrammaticality or a defective paradigm, but to the equally short and well-formed *hilf! and *lass!*. In these cases, no further ill-formed shortening to *hlf! or *lss! occurs. Since we work with a principle-based system with inviolable principles, we cannot gloss over this problem, especially since metaphony in Romance often leads to ineffable forms (Postma 2013, Nevins 2015). I do not solve the problem of vowel quantity in *hilf* etc. here, but only note that no verbs of the type *hebben-hibt* exist in German. Roots of the *hebben* type have undergone lengthening. So, a threat of defectivity might have been present in the past. Only *helfen* type verbs escaped defectivity. This class typically have roots with consonantal glides /r/ and /l/ in the nucleus: *helfen* 'help', *sterben* 'die', *werfen* 'throw'. As /l/ and /r/ are segments with an |A| element on a consonantal grid point, we hold this extra |A|-element responsible for retention of the grid point and the verb's survival in Modern German. More research is needed here.

8 Two previous accounts of the epenthesis conundrum

The description of German alternating verbs, epenthesis upon OCP clashes, the varying shape of the imperative morpheme, and their correlating character, are part of most grammars of Modern German, as well as every historical grammar of Middle High German. Nevertheless, there are only few attempts to account for the correlation theoretically. Most scholars are satisfied with a diachronic description of how these effects emerged, and ignore the question how they resist the wild tides of language change. As we have seen, even under language variation, e.g. *ficht* versus *fechtet*, the correlation retains (*fichtet*/*fecht*), which indicates that a synchronic force is at stake. Ignoring the lexicalist storage approach, there are only two serious synchronic attempts. The first is Neef's word design model (1997), which hypothesizes well-formedness conditions that apply on forms at the spellout level, briefly discussed in section 8.1. And there is Trommer's 2010 derivational approach, which is evaluated in section 8.2.

8.1 Neef's word design

Neef (1997) is the first who accounts for the anticorrelation between root alternation and epenthetic schwa in a synchronic framework. It is not a derivational approach but an account of the anticorrelation in terms of *word design* in paradigms. Neef assumes that particular forms in a paradigm have surface correspondences to sister forms, for instance, two forms must be equal or they must be distinct. In the case of 3sg present tense, there is, according to Neef, the
paradigmatic requirement that 3sg present tense is distinct from the verbal root. Upon a potential tt→t degemination in verbal stems terminating in a dental plosive, identity of root and 3sg present tense looms and schwa insertion is chosen to circumvent it. This gives correct predictions to 3sg, cf. (68)abc.

(68)  a. spalt+t → spaltt=spalt  hence epenthesis is needed: spalte  ok
     b. rat+Ut → rät=rät≠ rat  hence no epenthesis is needed  ok
     c. tret+Ut → trit+t=tritt ≠tret  hence no epenthesis is needed  ok
     d. spalt+st → spaltst ≠spalt  no epenthesis is needed  wrong!

It does not give the correct predictions for epenthetic schwa with 2sg forms, cf. (68)d. As an explanation, Neef proposes a second requirement for 2sg: its word design is based on 3sg: replace final t by st. We ignore here that this procedure is not without exception, (kannst<*kann, bist *< ist), as most theories have a problem with the copula. It does not work either on the surface forms in dental final roots /er häl/→ du *häls/hälst, it only works on the underlying form er hältt. Despite these problems, the relational status of 2sg and 3sg is clearly within the possibilities of word design model. What is more worrying is that the rules of word design are rather stipulative and hardly explanatory. An attractive feature of the theory is that it explains the correlation upon language variation: fechtet and ficht are both unequal to the stem /fecht/, while *fecht is equal and fichtet is redundant, as epenthesis is a last resort word repair. A serious drawback, on the other hand, is that the theory cannot be extended to the anticorrelation of vowel alternation (e→i in opposition to a→e) and zero imperatives: 1. treten>*trete/tritt!, but 2. schaffen>schlafe! and 3. binden-binde!/*bind!, i.e. the Imperative Conundrum discussed in the sections 2.1 and 5.2. This suggest that this model of surface constraints quickly meets its bounderies. The fundamental defect of this framework seems to be the implicit hypothesis that vowel alternations are relicts from the past and not produced by synchronic grammar.

8.2 Trommer's derivational approach

Trommer's derivational approach assumes that the interaction of umlaut and schwa-epenthesis in German 2sg/3sg verb forms is governed by synchronic grammar: concatenation + phonology. As empirical input, Trommer uses the following data from German diminutive formation. Trommer compares stem alternations in diminutive and stem alternations in present tense. Consider the diminutive pattern first.
(69) a. *Hund – Hündchen umlaut (Ӳ) (little) dog'
b. *Monat – Ø (no output) (little) month'
c. Bude – Büdchen Ӳ+drop of schwa (little) hut'
d. Haken – Häkchen Ӳ+drop of -en- (little) hook'
e. Vogel – Vögelchen Ӳ+transparency of -el- (little) bird'
f. Bruder – Brüderchen Ӳ+transparency of -er- (little) brother'

The uumlaut in the suffix leans to the adjacent stressed syllable Hund, as in Hündchen, turning [u] into [y], but if the stress is too far away, as in *Mönatchen, umlaut is ill-formed. The other forms mönätchen, monätchen and monatchen are ill-formed as well, cf. Hermans & Van Oostendorp (2008). In the case of Bude 'hut' and Haken 'hook' in (69)bc, the intervening syllable is dropped, but in the case of intervening -el/-er/(-em)31, Vogel 'bird', Bruder, the intervening syllable is transparent. Drawing the parallel with umlaut blocking by schwa in diminutives, Trommer now suggests that umlaut in strong verbs is blocked by epenthetic schwa. Just like the schwa in Büd(e)chen in (69)c, the epenthetic schwa in rät(e)t is deleted. Trommer's approach is a locality approach of the licensing of the floating umlaut factor. This locality hypothesis the core of Trommer's proposal. It consist of the interface assumption that one morphological head may not span more than two phonological domains. Under (70) we have two morphosyntactic heads, Y and X. In (70)a and b, the morphosyntactic head X_ij is split into two morphemes, x_i and x_j. However, while it realizes in adjacent domains in (70)a, it crosses an exponence line in (70)b. These crossing lines violate a constraint, called BIN-SPAN.

(70) a. morphosyntax ok Y X_ij
   phonology y x_i x_j
b. morphosyntax * Y X_ij
   phonology x_i y x_j

Notice that these crossing lines have reminiscences to alignment in autosegmental phonology, which provides the locality requirement in our model. The interesting ingredient in Trommer's proposal is that he applies his model on two empirical domains: on umlaut in diminutives and on umlaut in 23sg present tense verbs. The interface relations are given under (71).

31 This sequence does not occur in German but in Limburgian bodem-bödemke 'small bottom'.
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The crossing lines correctly rule out both Büdechen and rätet. The structure is rescued by dropping the intervening factor, -e- or –en-. As morpheme drop cannot be tolerated in general, an OT approach is invoked to handle it. To regulate morpheme drop, Trommer adopts three extra constraints, MAX V and MAX a, which impose to maximize morphemes with full vowels and schwa, respectively, and *ø (a ban on complete non spellout). Full vowels may not be dropped as easily as stand-alone schwa, while a complete non spellout, ø, i.e. the null parse, is ranked between these two. There is one more constraint needed: (stress) licensing of the floating umlaut factor ʒ, which our model also adopts. We give the two optimality tableaus in (72)–(73).

\[
\begin{array}{|c|c|c|c|c|}
\hline
& \text{MAX V} & \text{lic-Cor} & \text{BIN-Span} & *\emptyset & \text{MAX @} \\
\hline
\text{a. bud-e-ʒ-chen} & & * & & \\
\text{b. buʒd-e-chen} & & * & & \\
\text{c. ø} & & * & & \\
\text{d. buʒd--chen} & & * & & \\
\hline
\end{array}
\]

\[
\begin{array}{|c|c|c|c|c|}
\hline
& \text{MAX V} & \text{lic-Cor} & \text{BIN-Span} & *\emptyset & \text{MAX @} \\
\hline
\text{a. rat-e-ʒ-t} & & * & & \\
\text{b. raʒt-e--t} & & * & & \\
\text{c. ø} & & * & & \\
\text{d. raʒt--t} & & * & & \\
\hline
\end{array}
\]

We do not evaluate Trommer's OT analysis, which will be left to the reader. We only want to mention three problematic points. First, it is far from clear what the morphemic status of the umlaut factor is. Is it really part of the 23sg morpheme? This is crucial for the analysis to work. Referring to Müller (2006) and Trommer (2007), Trommer assumes it is a context-dependent number marker: ʒ=[-pl], inserted in a particular person environment: viz. the context [-1]. This makes the joint ordering together with the diminutive morpheme in (72) and the person

\[32\] A constraint MAX ʒ, ranked between *ø and Max @, should be added along with two extra candidates /budchen/ and /budechen/.
morpheme /t/ in (73) far from obvious. Historically, this /i/ morpheme was a binding vowel, a morpheme inserted after the root to avoid root-suffix derivation. For instance, verbs that lack this morpheme loose the integrity of the root, e.g. *bringen-bracht 'bring-brought' (with so called Primärberührung (De Boor & Wisniewski 1998). If the modern counterpart of this binding vowel still has morphemic status, it undermines the application of BIN-SPAN because we are not sure it is one and the same with the person ending. Secondly, it is not clear at all that the epenthetic morpheme EPEN has a status at the morphosyntax-phonology interface. If it is really an epenthetically inserted segment, as Trommer assumes, it is equally likely that it is not yet there when BIN-SPAN is evaluated. De facto, Trommer's analysis presupposes that EPEN is a morpheme like the others, and subject to a specific ordering with respect to other morphemes. It means that EPEN must correspond to a particular morphosyntactic projection. Also this consideration undermines the application of BIN-SPAN. In our implementation, EPEN is identical to the umlaut factor ʒ.

Our competitive tier model has various theoretical assumptions in common with Trommer's derivational approach although they differ in implementation. While Trommer opts for an OT implementation, our competitive tier model is a principle-based account. Let us compare the theoretical assumptions. Under (74) we give a comparative chart of Trommer's five assumptions and their counterparts in the Competitive Tier Model.

<table>
<thead>
<tr>
<th>(74)</th>
<th>Assumptions in Trommer (2010)</th>
<th>This study (CTM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Synchrony</td>
<td>idem</td>
</tr>
<tr>
<td></td>
<td>Umlaut is produced by synchronic grammar. Root and umlaut factor ʒ are concatenated by morphology. The umlaut morpheme is defective: it is floating.</td>
<td>idem (+ alignment)</td>
</tr>
<tr>
<td>2.</td>
<td>Floating</td>
<td>(idem)</td>
</tr>
<tr>
<td></td>
<td>Floating ʒ targets all positions which are open to full segments.</td>
<td>generalized to all verbs</td>
</tr>
<tr>
<td>3.</td>
<td>Configuration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In 23sg forms ʒ is a sub-exponent of verb agreement, and … restricted to a specific lexical class of verbs.</td>
<td>(idem)</td>
</tr>
<tr>
<td>4.</td>
<td>Licensing</td>
<td>idem</td>
</tr>
<tr>
<td></td>
<td>Umlaut spreads to the stress due to phonological licensing constraints</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Locality</td>
<td>alignment</td>
</tr>
<tr>
<td></td>
<td>A feature span is (maximally) binary (*BIN-SPAN).</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Additional hypotheses:</td>
<td>competitive V2-tier + alignment</td>
</tr>
<tr>
<td></td>
<td>Deletion rules (V Max, schwa Max, *ø)</td>
<td></td>
</tr>
</tbody>
</table>
The theoretical assumptions 1, 2, and 4 are attractive being plausible hypotheses. These are identical to the theoretical presuppositions of the model we developed in this study. As we have seen above, the first part of hypothesis 3 is crucial for Trommer's analysis to work, and it is compatible with our model, although it plays no role in ours. The second part of hypotheses 3 (limitation to strong verbs) is redundant in our model as strong and weak verbs have the same 23sg present tense suffix. Our CTM model only depends on the hypothesis of a competitive tier, in addition to standard assumptions of alignment. Moreover, the CTM model generalizes over weak and strong verbs. Despite the doubtful assumption in (74)-3 and the questionable deletion rules in (74)-6 in Trommer's model, the parallel between epenthetic schwa, blocking umlaut in 23sg, and the class marker schwa, blocking umlaut in diminutives, is too interesting not to consider seriously. Let us then analyze how the competitive tier model might handle this parallel. In (75) we apply the nominal umlaut factor that we introduced in (4) for Pomeranian: a floating |I| element on the competitive V2 tier. This floating |I| cannot stand on its deactivated grid point and aligns to the first full grid point from right-to-left, i.e. the grid point in the root. In doing so, it expulses the [@], i.e. [ə].

\[
\begin{array}{c|c|c|c|c|}
\hline
\text{Bude} & \text{DIM} & \text{Büdchen} \\
\hline
\text{V2-tier} & [@] & |I| & [@] & |I| \\
\text{b} \cdot \text{d} \rightarrow @ \text{chen} \rightarrow \text{b} \cdot \text{d} \rightarrow @ \text{chen} \\
\text{V1-tier} & |U| & |U| \\
\hline
\end{array}
\]

Let us assume that /n, r, l, m/ participate in the consonantal tier, and that only syllabic /n/, being without any place features, stands on a deactivated grid point on the V2-tier, just like the place-depleted schwa. (It is the nasal manner of schwa, while /r, l, m/ are consonants with place features |A| and |U|). We then get the opposition in (76)-(77). In these configurations, [ən] patterns with [ə], being both expelled by the umlaut factor.

\[
\begin{array}{c|c|c|c|c|}
\hline
\text{Haken} & \text{DIM} & \text{Häkchen} \\
\hline
\text{V2-tier} & |N| & |I| & |N| & |I| \\
\text{h} \cdot \text{k} \rightarrow @ \text{chen} \rightarrow \text{h} \cdot \text{k} \rightarrow @ \text{chen} \\
\text{V1-tier} & |A| & |A| \\
\hline
\end{array}
\]
The suffixes [əl], [ər], and [əm], on the other hand, are unaffected as they are in situ licensed by spreading the place features in /r/, /l/ and /m/ (on the V1 tier). This is the same mechanism as assumed in Trommer's analysis, albeit more articulated.

\[
\begin{array}{ccc}
\text{Bruder} & \text{DIM} & \text{Brüder} \\
\text{V2-tier} & | & | \\
\text{V1-tier} & | & | \\
\end{array}
\]

Notice that the hypothesis that German syllabic /n/ resides on a V2-tier has immediate consequences for its behaviour of those syllabic n-segments that is part of the verbal stem, e.g. *nennen*, *brennen*, *denken*, discussed in section 5.6, which might be expelled on past tense formation (ablaut), briefly discussed in section 10. This illustrates that the model presented here are extendible to the umlaut cases discussed in Trommer (2010). If so, the empirical coverage of the competitive tier model is broader than Trommer's model, which ignores the e→i alternations, the imperative conundrum, and the shortening conundrum.

9 Application to alternating verbs in Pomeranian

Pomeranian (Tressmann 2006, Postma 2016) has lost the umlauting class of alternating verbs completely, just as the Low Saxon dialect (Gronings) in the Netherlands did (Reker 1989): there are no raten-rät verbs. The other type is in full swing: *geewa - hai giwt* 'to give- he gives', which has the same analysis as in German, where |A| has pushed out. This class has slightly extended, for instance, *gaïta-git* (he) pour(s)', *hai-ta-hit* 'be called'. In addition to this, a new class emerged. Under (78) we give some typical cases, of the new alternating verbs, where in addition to a vowel change there is vowel shortening (just as in German).

\[
\begin{array}{l}
(78) \quad \text{Alternating verbs in Pomeranian, taken from Tressmann (2006).} \\
a. \quad \text{fal+} \ \mathfrak{I}t \quad [a] \quad \rightarrow \quad \text{fült} \quad [y]^{33} \quad \text{'falls'} \\
\quad \text{forlair+} \ \mathfrak{I}t \quad [a:] \quad \rightarrow \quad \text{forlürt} \quad [y] \quad \text{'looses'} \\
b. \quad \text{koom+} \ \mathfrak{I}t \quad [ɔ:] \quad \rightarrow \quad \text{kümt} \quad [y] \quad \text{'comes'} \\
c. \quad \text{krup+} \ \mathfrak{I}t \quad [u:] \quad \rightarrow \quad \text{krüpt} \quad [y] \quad \text{'creeps'} \\
d. \quad \text{dæ:g+} \ \mathfrak{I}t \quad [ɔ:] \quad \rightarrow \quad \text{dögt} \quad [œ]^{33} \quad \text{'carries'} \\
e. \quad \text{stöit+} \ \mathfrak{I}t \quad [ø:] \quad \rightarrow \quad \text{stöt} \quad [œ] \quad \text{'bumps'}
\end{array}
\]

\[33\] Pomeranian short complex vowels are usually accompanied with a pre-articulation, e.g. the short rounded low mid vowel [œ] as [œ] and the short high rounded vowel [y] as [y], realized on one timeslot. Also post-articulated realizations can be heard. For details, cf. Postma (forthcoming).
As one can inspect form (78), there is addition of \(|U|+|I|\) to the root, which is sometimes competitive with the stem vowel, as in *fala* 'fall' and *kooma* 'come', and sometimes coalescent, as in *dråga* 'carry' and *stöita* 'bump'. Just as for German, we assume the competition effect to be caused by \(|I|\) on the V2-tier. As this tier can only host one element, we assume that it is \(|U|\) that is on the V1-tier (cf. (40)).

(79) Umlaut verbal suffix \(\mathfrak{I}\) in Pomeranian

| V2-tier      | \(|I|\) |
|--------------|---------|
|              |         |

| V1-tier      | \(|U|\) |
|--------------|---------|

Let us start with the typical Pomeranian case, where the verbal root is on the V2 tier, cf. (4), e.g. *fala*-*fült* 'fall' and *forlaira*-*förürt* 'loose(s)'. *Fala* is analyzed under (80).

(80) *fala* - *fült* 'fall'

| V2-tier      | \(|A|\) | \(|I|\) | \(|A|\) | \(|I|\) |
|--------------|-------|-------|-------|-------|
|              |       |       |       |       |

\(f\cdot l + \mathfrak{I} t \rightarrow f\cdot l t \; \text{fäl+} \; \mathfrak{I} t \rightarrow \text{fült}\)

| V1-tier      | \(|U|\) |
|--------------|--------|

As we see, the suffixal I-element pushes out the radical \(|A|\), which is on the V2-tier. Together with the U element on the V1 tier, the root vowel becomes [y]. A variant of this case is *kooma* 'come' which has a complex vowel. It is given under (81).

(81) *kooma* - *kümt* 'come'

| V2-tier      | \(|A|\) | \(|I|\) | \(|A|\) | \(|I|\) |
|--------------|-------|-------|-------|-------|
|              |       |       |       |       |

\(k\cdot m + \mathfrak{I} t \rightarrow k\cdot m t \; \text{koom+} \; \mathfrak{I} t \rightarrow \text{kümt}\)

| V1-tier      | \(|U|\) | \(|U|\) | \(|U+U|=|U|\) |
|--------------|-------|-------|----------------|

The other cases under (78) are completely straightforward. We give them under (82)-(84) for reference only.
All these cases nicely show the coalescence of elements on the V1-tier and the competition of elements on the V2-tier. Notice that shortening follows the generalization made for German. As Pomeranian always have expulsion of |A| or |U|, 23sg present tense always shortens.

10 Some speculations on Ablaut

It has been argued that ablaut (here: vowel alternation over tenses) has a quite different status than umlaut (here: vowel alternation over person features) in German: ablaut does not seem a productive process (anymore) in Modern German. Ablauting forms do not have a derivational relation (anymore) and are lexically related (Wiese 1987, 1996). Indeed, this is what we thus far assumed for the sake of exposition. On the other hand, ablaut must have been a productive process in Proto-Germanic and its possible inclusion in the model should at least be discussed. If we include verbal ablaut into the theory, e.g. the vowel alternation in helfen-half-geholfen, of which helf- has its |I| on the V1 tier, the assumption of competition on the V1-tier seems unavoidable. This can be extracted from comparing umlaut and ablaut. In (85) we repeat the helfen–hilft structure as was assumed in (32). which has an I on the V1 tier.
The structure in (85) suggests that the V1 tier is competitive upon past tense |A|-suffixation, as represented under (86).

(86) half- PAST half-  
V2-tier |A| |A| |A| |A|  
h • l f + $\rightarrow$ h • l f helf + $\rightarrow$ hilft  
V1-tier |I| |I| |I| |I| |

Similar indications of element competition on the V1-tier are present in Pomeranian. For instance, as we have seen above, 23sg inflection expulses |A| from kooma on the V2-tier, under addition of |I| (k[ɔ:]ma $\rightarrow$ kümt cf. (81)), repeated here as (87).

(87) kooma - kümt 'come'  
V2 tier |A| |I| |A| |I|  (umlaut)  
k • m + $\rightarrow$ k • m t  
V1 tier |U| |U| |U| |

However, upon adding the floating |I| past suffix the Pomeranian, forms emerge like k[ɔ:]ma-k[ai]m 'come/came', m[ɔ:]ka-m[ai]k 'make-made', where the |U| is expelled, which sits on the V1-tier.

(88) koom - kaim 'come/came'  
V2 tier |A| |A|  (ablaut)  
k • m + $\rightarrow$ k • m  
V1 tier |U| |U| |U| |

Notice that this would produce kem, not kaim. The broken form kaim suggests that |A| and |I| sit on the V2-tier. To establish that, we need Tier Conflation to the V2-tier. We mentioned this possibility in our theoretical section in (28). On the other hand, if we need Tier Conflation 2 to
produce broken form /ai/, we better apply TC2 before adding the suffix. We then can retain the V2-tier as the only competitive tier.

We opt for this implementation here: competition in ablaut comes about by Tier Conflation towards the V2-tier (TC2) before past tense suffixation occurs.

\[
\begin{array}{|c|c|c|c|c|}
\hline
(89) & \text{V2-tier} & \text{TC2} & \text{PAST} & \text{end} \\
\hline
& |A| & |I| & |I| & |A| \\
& |f| & |A| & |A| & |A| \\
& |l| & |I| & |I| & |I| \\
& |f| & |l| & |f| & |l| \\
& |f| & |l| & |f| & |l| \\
\hline
\end{array}
\]

For Pomeranian, which has an |I| suffix in most past tenses, we get the structure under (90).

\[
\begin{array}{|c|c|c|c|c|}
\hline
(90) & \text{V2-tier} & \text{TC2} & \text{PAST} & \text{end} \\
\hline
& |A| & |U| & |A| & |I| \\
& |A| & |I| & |A| & |I| \\
& |m| & |I| & |I| & |I| \\
& |m| & |I| & |I| & |I| \\
& |m| & |I| & |I| & |I| \\
& |m| & |I| & |I| & |I| \\
\hline
\end{array}
\]

The expulsion of |U| in 'come' in the past tense becomes visible from Dutch, where the expelled |U| by |@| on the V2-tier realizes in the onset in this verb: /kom-/kwam/- 'come-came'. This broken form is a typical V2-tier property.

\[
\begin{array}{|c|c|c|c|c|c|}
\hline
(29) & \text{Onset realization of expelled elements} \\
\hline
& \text{V2-tier} & |A| & |U| & |A| & |@| \\
& & |A| & |I| & |A| & |@| \\
& & |I| & |I| & |I| & |I| \\
& & |m| & |m| & |m| & |m| \\
& & |m| & |m| & |m| & |m| \\
& & |m| & |m| & |m| & |m| \\
& & |m| & |m| & |m| & |m| \\
& |U| & |U| & |U| & |U| & |U| \\
\hline
\end{array}
\]

Apparently, expelled elements may get onset realization in Dutch.\(^{34}\) Cases of metathesis in older and dialectal Dutch (werken-wrocht 'work-wrought') might be a reflex of such expulsion effects + onset realization of nucleus material. This is even more probable as it precisely happens in the verbal class with weak past formation -t instead of d/t+@, i.e. it is probably |@|+t with floating schwa). It is this floating |@| that causes the so-called Primärberührung in

\[34\] The onset realizations in Frisian should also be mentioned in this context, e.g. do:ra-dwast 'dare(d)', slipe-slept 'sleep/slept'. The class of verbs with Primärberührung is especially developed in Ingvaeonic variants of West-Germanic. In Frisian, onset realization in nominal paradigms has become productive (Booij 1989, Postma 1990): do:r-dwarren 'door(s)'.

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these bare –t suffixal verbs (Sanders 1983, de Boor & Wisniewski 1997, Philippa et al 2003-2008, Anderwald 2009:4), where parts of the root, typically the |ʔ| element, is expelled from the coda: k/g→x, p/b→f, d/t→0/s (Pom. mōiga-mocht 'may-might', köipa-köft 'buy bought', waita-wüst 'know-knew'). In Dutch werken-wrocht, there is a sequence of expulsions upon such deviant |@|+t suffixation, |@| expulsing |ʔ| from the coda to the nucleus ([k]→[x]), and |ʔ| expulsing /t/, i.e. an |A| glide on a consonantal grid point, from the nucleus (with onset realization).

It may be clear that these questions on the status of past tense effects (on V1-tier or on V2-tier or on both) deserve further research. We only added this example as an illustration of the possibility of Tier Conflation towards the V2-tier (TC2), given in our axiomatic section.

11 Summary, conclusions and discussion

Competition of segmental material is inherent in all phonological proposals of template satisfaction (Goldsmith 1976, McCarthy 1978, Steriade 1982, Marantz 1982, and subsequent work). Segments are aligned with a prosodic template and compete for prosodic space. In this paper we show that vocalic template satisfaction display competition of elements, i.e. template satisfaction applies on the building blocks of segments (in Element Theory). We have shown that — in terms of Element Theory — there must be two types of vocalic tiers: a coalescent tier (V1-tier) where the addition of an element causes merger, and a competitive tier (V2-tier), where addition of an element may expel another vowel from the prosodic template. This allowed us to solve the epenthesis conundrum, which describes the fact that epenthetic vowels are blocked in alternating present tenses, as well as the imperative conundrum, that describes that alternating verbs sometimes derive the imperative from the 23sg, sometimes from the non-23 form. The facts explained by the Competitive Tier Model are cast in the table in (91).

(91) Distribution of schwa in German paradigms: 23sg present tense & imp. sg.

<table>
<thead>
<tr>
<th>Class</th>
<th>Infinitive</th>
<th>2sg Present Tense</th>
<th>Imperative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>strong/alternating</td>
<td>additive/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in present</td>
<td>subtractive</td>
</tr>
<tr>
<td>class 0</td>
<td>spielen</td>
<td>w</td>
<td>no</td>
</tr>
<tr>
<td>class 1</td>
<td>arbeiten</td>
<td>w</td>
<td>no</td>
</tr>
<tr>
<td>class 2</td>
<td>raten</td>
<td>s</td>
<td>yes</td>
</tr>
<tr>
<td>class 3a</td>
<td>lassen</td>
<td>s</td>
<td>yes</td>
</tr>
<tr>
<td>class 3b</td>
<td>treten</td>
<td>s</td>
<td>yes</td>
</tr>
<tr>
<td>class 4</td>
<td>leiden</td>
<td>s</td>
<td>no</td>
</tr>
</tbody>
</table>
Red ovals: Epenthesis Conundrum; green ovals: Imperative Conundrum. All cells are captured in the Competitive Tier Model. The symbol \( \Rightarrow \) indicates subtraction.

We used the principles under (92) and the assignment by the Lexicon under (93):

(92) Principles

- Template satisfaction in the phonology (not the lexicon)
- Alignment (i.e. competition of segments/elements)
- Edge-In Alignment (from the affix inward)

(93) Assignments

<table>
<thead>
<tr>
<th>V1 tier</th>
<th>V2 tier</th>
</tr>
</thead>
<tbody>
<tr>
<td>(vowels of...)</td>
<td>(vowels of...)</td>
</tr>
<tr>
<td>• weak verbal stems</td>
<td>• parasitic element</td>
</tr>
<tr>
<td>• strong verbs (I-A-U)</td>
<td>• parasitic element</td>
</tr>
<tr>
<td>•</td>
<td>( @</td>
</tr>
<tr>
<td>•</td>
<td>( @</td>
</tr>
<tr>
<td></td>
<td>• floating</td>
</tr>
</tbody>
</table>

The foundation of these lexical assignments is not entirely clear: what rules the assignment of segments to a specific tier? A connection with morpheme status seems at stake, at least historically. Suffixes seem to realize their vocalic material on the V2-tier and retain this assignment even after reanalysis as part of the root. The competitive nature of suffixes and the competitive nature of the V2 tier might, therefore, be related.\(^{35}\) This can possibly been formulated in terms of color (Van Oostendorp 2006). Alternatively, the vowel's relation with consonants might be at stake, as was suggested in Postma (2014), where V2-tier |\( I| \) was identified with suffixal /dt/ and V2-tier |\( U| \) was identified with past tense suffixal /g/ in Flemish. The consonantal nature of the V2-tier can also be extracted from the apparent intervening nature of epenthetic schwa between two heteromorphemic dentals, -tə/-dət. This schwa can only solve a consonantal OCP-problem if it is visible to the consonants or upon tier conflation. The competitive nature might also be a vocalic counterpart of the competitive nature of consonants in alignment processes. This might be related to the simplicity of vowels in Semitic. Finally,

\(^{35}\) For an interesting Berber case of morpheme competition by phonological template satisfaction, cf. Lahrouchi (2013).
the competitive nature might be related to headedness in the sense of Element Theory (Backley & Takahashi 1996, Backley 2011).

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