

RESEARCH

The competitive tier model – Element subtraction in German and Pomeranian

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Competition of segmental material is inherent to all proposals of phonological template satisfaction. Segments are aligned with a prosodic template and compete for prosodic space. This vowel competition for space is well-known from the Semitic languages. 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]-[ɪ] and [e]-[ɪ] 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]t*/**rett* versus **rät[ə]t*/*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:]-[ɪ] versus [a:]-[ɛ:]. A formal model is presented that provides us with a calculus of coalescence and competition of phonological features.

Keywords: Element Theory; umlaut/metaphony; autosegmental theory; ablaut; subtractive morphology; present tense morphology

Languages: Standard German; Pomeranian; Dutch; Low Saxon; Limburgian; Frisian.

1 Introduction

Competition of segmental material is inherent in phonological proposals of template satisfaction (Goldsmith 1976; McCarthy 1978; Marantz 1982; Steriade 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 *kitabā*. 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 *kiteba* are not produced either, where a and i share a prosodic slot.

- | | |
|---|---|
| <p>(1) pattern: kitaba
 CVCVCV → CVCVCV

 melody: i a
 {ia}</p> | <p>(2) pattern: *kitiba
 CVCVCV → *CVCVCV

 melody: i a
 {ia}</p> |
|---|---|

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 obscures the competition effect.

Competition effects in unlauded forms 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.

- | | | | | |
|-----|------------------|---------------|----------------|------------------------------|
| (3) | <i>foot-feet</i> | <i>hat(s)</i> | <i>book(s)</i> | |
| a. | fu:s – fy:sə | hu:t – hy:tə | bu:x – by:çər | [u-y] High German |
| b. | fo:t – fœ:tə | ho:d – hœ:(r) | bo:k – bæ:kə | [o-œ] Low Saxon ¹ |
| c. | faut – fuit | haud – huir | bauk – buikər | [au-ui] Pomeranian |

In these lexemes, the plural is formed by adding a floating |I|-element as a suffix to the stem (Hamans 1985; Lodge 1986; Lieber 1987; Wiese 1987; Yu 1992; Hermans & Van Oostendorp 2008; Trommer 2010), apart from segmental material.² 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 us, is that no complex vowels are present. |A| and |U| in the singular *faut* are realized as distinct segments [fa^ut], the broken counterpart of the **Low** German /foot/. Similarly, in the plural *fuit*, |U| and |I| are also realized as distinct segments [fuⁱt], the broken counterpart of **High** German /füüs/.³ 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 is not realized: it is “pushed out” upon right-to-left alignment⁴ of the melody over the available grid points. |A| is “not parsed”, because it is without grid point.

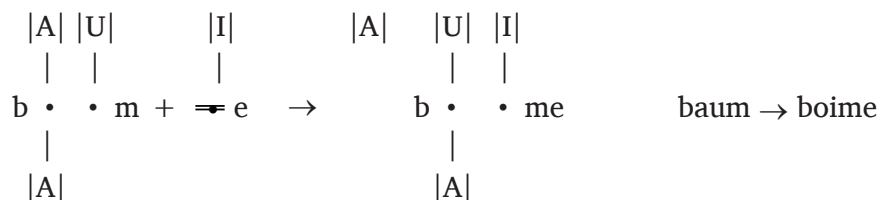
- | | | | |
|-----|-------------------|--------|----------------------------|
| (4) | <i>Pomeranian</i> | umlaut | |
| | A U | I | A U I |
| | | | |
| | f • • t + | ≠ | → f • • t faut → fuit |

The competition effect in (4) is wide-spread in Pomeranian morphology, both in inflection and derivation, for instance in denominal verbs: *blaud* ‘blood’ – *bluira* ‘to bleed’ (Postma 2018), where an umlaut feature is added. Competition gives rise to subtractive effects in phonology: the addition of |I| to *faut* causes a subtraction of |A| from the root.

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).
² We take umlaut to be a consequence of a suffixal floating element. Whether this morpheme actually gets exponence or not, depends on the presence of umlaut blocking contexts (“umlauthinderend”), cf. Paul (1918: 25). We identify two blocking contexts: phase boundaries (#) and two equal elements (or rather a spread element) on the same tier.
³ The /t/-/s/ alternation is an independent phonological sound law (“Second High German sound shift”).
⁴ So called “Edge-In” (Yip 1988).

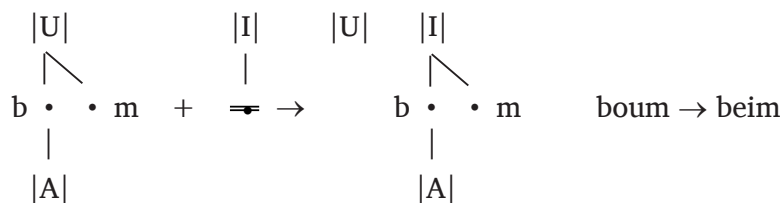
Modern German exhibits competition effects in plural forms as well, albeit in less clear form, e.g. *b[au]m-b[oi]me*, as illustrated in (5). The only difference with Pomeranian is that an extra |A| feature is superposed on it. As this element is not affected by the addition of the umlaut, it must be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

(5) German



Under (6) we give an example of the well-known Brabant/Limburgian o→e umlaut (e.g. *dorst-derst* ‘thirst’; Franck 1910: 41ff) from the Limburgian dialect of Opglabbeek, *b[ou]m-b[ei]m* ‘tree(s)’ where an |U|-element is expelled.

(6) (Opglabbeek)⁶



Similar |U| expulsion effects are found in Luxemburgian (Gilles 2015), Saarbrücken dialect (Steitz 1981: 69, *apud* Klein 2000: 18–19) and Yiddish (Weinreich [1973]2008: 488; Noam Faust, *pers. comm.*). Klein explicitly observes the subtraction of |U|.

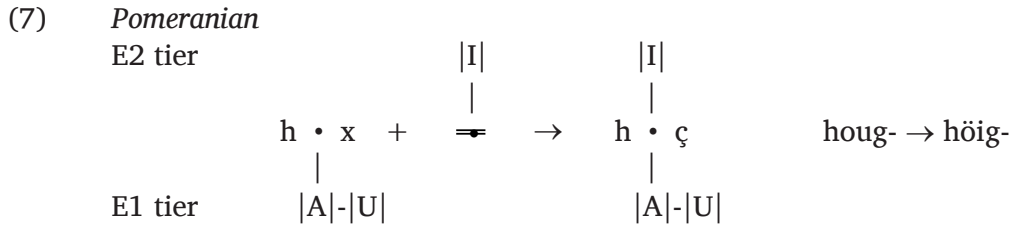
“(T)he Saarbrücken data [...] shows that the back rounded vowels in the dialect of Saarbrücken appear as the front unrounded vowels under umlaut. [...] Any formal cross-linguistic analysis of fronting umlaut must capture the facts of unrounding versus rounding of non-low vowels adduced above as a language-specific property.” (Klein 2000: 19).

In sum, Pomeranian shows competitive effect in pure form, as we saw under (4). Other roots in Pomeranian, however, do realize complex vowels, for instance *h[ou]g -h[œ:i]ger* ‘high(er)’, *dr[ɔ:]ga-hai dr[ø]gt* ‘to carry/he carries’ with a short vowel, or lexemes like *hüüt* ‘today’ (cf. Germ. *heute* ‘today’, Du. *huid(ig)* ‘at present’), which has a long complex vowel [y:]. In sum, Pomeranian exhibits both competition and coalescence of vocalic material. The question is then, how we disentangle coalescent properties and competing properties, empirically and theoretically. We argue that natural language allows for two vocalic tiers, one where elements are in competition and one where elements are coalescent and where complex vowels are created. We show that the assumption of competition side-by-side to coalescence provides us with a clue to shed light on three well-known riddles in

⁵ Independent evidence that there is an extra |A| on an independent tier, comes from Old Frisian *bām*. Proto Germanic *baum* must have had |U| on some tier which has undergone expulsion in Old Frisian. So where was its |A|? Note that Modern Frisian has *bjem-* in the plural/diminutive and composita. We then have the sequence for Frisian: 1. *baum* > 2. *baam* > 3. *baim* > 4. *beem* > 5. *bjem-*. So first an |U| element and then an |I| element are expelled while |A| remains constant over the various processes. The |I| in stage 3 is a generalized umlaut element which has been reanalyzed as part of the root. |A|, however, was not affected. Hence, an |A| must have been present in a way that was autosegmentally disconnected.

⁶ GTRP, location L416p. The singular has accent 2 (level tone), the plural accent 1 (falling tone).

German philology. We call the competitive tier *the E2 tier*. The well-known (coalescent) tier is called *the E1 tier*.

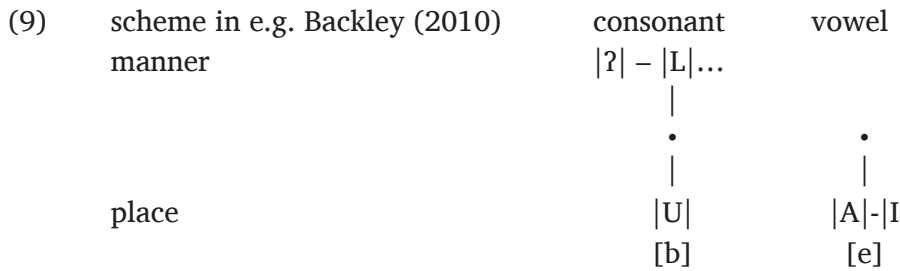


In general, we assume that two types of tiers are provided by Universal Grammar and the choice between the type of tiers and the segmental filling of those tiers is specified by the lexicon. We summarize the proposal under (8).

- (8) • Natural language has two autosegmental vocalic tiers:
 - E1 tier is coalescent
 - E2 tier is competitive
- Competitive Principle
 - Every grid point is linked to maximally one element on the E2 tier.
- The umlaut factor (floating |I|-element) in German realizes on the E2 tier.
- Most lexical roots realize their vowels on the E1 tier, but some roots realize vowels (also) on the E2 tier.

These assumptions create the possibility of apparent *subtraction* of phonological elements, under influence of standard concatenative morphological processes, as illustrated under (4)–(5) above.⁷ In the rest of this paper, we elaborate the two tier model in more detail. It allows us to tackle three riddles of German philology.

At first sight, the existence of two different tiers for the sub-components of vowel comes as a surprise: why would natural language be designed that way? Why would elements be sometimes coalescent and sometimes competitive? The short answer is that we do not know. But we can give the two-tier hypothesis plausibility by a comparison with the consonantal system. Consonants typically have two types of elements: manner and place elements. Element Theory distinguishes (at least) three place elements (IAU) and three manner elements (|ʔ|, |L|, |H|), where |ʔ| stands for obstruent, |L|(ow) for nasality/voice (also called |N|), and |H|(igh) for aspiration/frication. Consonants are combinations of manner features but, according to standard ET, consonants can also have place features, for instance, [b] is {|ʔL|—|U|}. Vowels, on the other hand, are seemingly mere combinations of place features; no manner feature is assigned. This creates the asymmetric situation given under (9).



⁷ In virtually all cases, we discuss vowels and their interaction. Consonants are mostly invisible for the processes we consider in this paper: they are autosegmentally disconnected. By matter of symmetry, we assume a similar distinction between an E1 tier and an E2 tier for consonants. There is evidence, however, that the E2 tiers of vowels and consonants coincide: they form in fact one tier, where elements of vowels and consonants interact in competition, alignment, and OCP effects.

We hypothesize that this asymmetry in the phonological system is only apparent. Also vowels have manner. This fact is only obscured by the fact that vowels use place features for manner purposes, i.e. the empty manner slot in (9) is taken by a place feature. As we will see in section 7, this manner dimension in vowels shows up as a lax-tense opposition. Laxness constitutes a *manner* of realization. In the mean time, the symmetrization of (9) should not be interpreted as if manner as such would be competitive, or, as if manner must be identified with the E2 tier. On the contrary: manner elements do combine (cf. Backley 2011). The consonantal tier is coalescent, just as the vocalic tier. There are indications, however, that one manner or place element in consonants may participate in the competitive E2 tier. It is the cause of consonant gradation in some West Germanic inflectional paradigms (see section 8.2).

The article is structured as follows. First we will sketch three riddles in German grammar, the imperative conundrum, the epenthesis conundrum, and the shortening conundrum in section 2. These riddles all refer to 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 coalescence: a bounded (semi)lattice. It introduces the theoretical background of schwa, i.e. the element $|\text{@}|$. The application to German vowel alternation is given in section 5.1. Section 5.2 applies the model to the imperative conundrum, while it is applied to the epenthesis conundrum in section 5.3. Section 5.4 generalizes the model to weak verbs (the regular verb class), which is a trivial special case of the alternating verbs. Section 5.5 deals with some strong verbs that have epenthesis. Section 5.6 discusses an exceptional verb class with so-called rückumlaut. Section 5.7 discusses seven counterexamples of verbs where umlaut is blocked. After the discussion of another apparent counterexample of the competitive nature in section 6, we discuss the more difficult third riddle: the shortening conundrum (section 7), which we will not completely solve. In section 8, we return to Pomeranian and apply the theory to the three conundrums in this language. The dialectology of the umlaut factor is discussed in section 9. In section 10, we confront the model with two previous accounts of the epenthesis conundrum: the declarative approach in Neef (1997), and the phonological approach in Trommer (2010). The paper closes off by summarizing the results, giving conclusions, some remaining problems, and a speculation on the origin and nature of the competitive tier.

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 behavior in verbal classes. One is the imperative conundrum, the other the epenthesis conundrum, the third is the shortening conundrum. The data set covered by the model is the morphological data of written Standard German, as we find it in prescriptive 20th century grammars, for instance Duden (1984), Griesbach (1991), Helbig & Buscha (2001).⁸

Before turning to the riddles, we must discuss a dimension of German morphology that concerns these. This is the phenomenon that the present tense shows root vowel alternation for some verbs but not in others. In 23SG present tense, the root vowel changes in some verbs compared to the other forms of the paradigm. We call these “alternating verbs”. We list two typical examples in (10) next to three non-alternating verbs, *sparen* ‘to save’, *singen* ‘to sing’, and *denken* ‘to think’, which lack root alternation in the present tense.

⁸ An instructive language site to check the various forms is www.verbix.com.

(10)	<i>schlafen</i> 'sleep'		<i>nehmen</i> 'take'		<i>sparen</i> 'save'	<i>singen</i> 'sing'	<i>denken</i> 'think'
					section 5.4	section 5.5	section 5.6
1SG	schlafe	[a:]	nehme	[e:]	spare	singe	denke
2SG	schläfst	[e:] ⁹	nimmst	[ɪ]	sparst	singst	denkst
3SG	schläft	[e:]	nimmt	[ɪ]	spart	singt	denkt
1PL	schlafen	[a:]	nehmen	[e:]	sparen	singen	denken
2PL	schlaft	[a:]	nehmt	[e:]	spart	singt	denkt
3PL	schlafen	[a:]	nehmen	[e:]	sparen	singen	denken

All alternating verbs are strong verbs, i.e. they also show vowel alternation over the tenses, *schlafen* – *schliefe* – *geschlafen*, and *nehmen* – *nahm* – *genommen*, but non-alternating verbs are either weak (*sparen*), strong (*singen*), or mixed (*denken*).¹⁰

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.¹¹ Moreover, there is an effect on the shape of the suffix: obligatorily null in the case of the e-i class, optional (ə) in the case of the a-e class,¹² and /ə/ in the non-alternating class.¹³

(11) 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 conundrum, therefore, involves 1. the type of alternating stem, and 2. the stem chosen, 3. the shape of the ending, and 4. the correlation between these.

⁹ 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].

¹⁰ Though absent in modern standard High German, there is a weak class with alternation in the present tense (23SG). It is accompanied with consonant gradation, e.g. Pomeranian *köipa-hai köft* 'he buy(s)'. Dutch *hebben-heeft* 'to have/has'. They are a special case of the class with rückumlaut. We sketch an analysis in section 8.2.

¹¹ There is one exception: *werden* 'to become', which has *werde!* as its imperative, i.e. takes the non-23 stem. At the same time, it does not drop the final -e. In fact, this verb confirms the relation between stem-alternation and zero-ending in the e-i class. It is probable that *werde* is a subjunctive form used as a suppletive form for an ill-formed imperative.

¹² Historically, the imperative suffix was a \emptyset -suffix in strong verbs but it gradually adopted the e-ending of the weak verbs. The present day grammars of Standard German capture this as an optionality in the written language.

¹³ The underlying ending is -ə, both historically and synchronically, but there is a synchronic rule of schwa apocope, blocked in verbs with roots ending in a dental stop *warte!* 'wait', or in bisyllabic roots *feiere!* 'celebrate', or syllabic nasals *atme!* 'breathe', which obligatorily show the underlying form.

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 in the grammar, not only in the verbal system, for instance in adjectives, e.g. German *heiß-heiß[ə]st* 'hot-hottest'. At first glance, this is a rather late post-lexical phenomenon. However, this process depends on deep grammatical properties as can be inspected from the closely related Dutch/Frisian/Flemish, *raad + t* → *raadt* 'guess(es)', *vers + st* → *verst* 'fresh(est)', 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" morphophonological 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* → *spaltət*. 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 (12) we give the distribution.

- (12) Distribution of epenthesis in verbs in German
- | | | | |
|----|-----------------|--------------|-------------------|
| a. | spielen 'play' | spiel- + t | → spielt |
| | | spiel- + st | → spielst |
| b. | spalten 'split' | spalt- + t | → spaltet |
| | | spalt- + st | → spaltst |
| c. | halten 'hold' | hält- + t | → hält |
| | | hält- + st | → hältst |
| d. | treten 'step' | tritt- + t | → tritt |
| | | tritt- + st | → trittst |
| e. | fechten 'fight' | ficht + t | → ficht |
| | | ficht + st | → fichtst/fichtst |
| | | or fecht + t | → fechtet |
| | | fecht + st | → fechtest |

If a verb accidentally fluctuates between the alternating class and the non-alternating class, as *fechten* 'to fight/swordplay' does, the schwa epenthesis co-varies, as illustrated under (12)e. Mixed cases such as **fecht* or **fichtst* 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 (13).

- (13) Epenthesis conundrum
- Alternating verbs do not show schwa epenthesis upon OCP clashes in 23SG present tense *er rät, tritt*
 - Non-alternating verbs (be they strong or weak) have the stem + schwa + ending as the 23SG present tense upon OCP clashes *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. Verbs without vowel alternation do not shorten, only alternating verbs do. The pattern is, however, a mystery: verbs with e→i alternation have it: the vowel is a long [e:] in *geben*, *nehmen*, *treten*, and is a short [i] in the imperatives *gib!*, *nimm!*, *tritt!*, as well as in 23SG present tense, e.g. *(er) gibt*, *nimmt*, *tritt*. In *schl[a:]gen*, *r[a:]ten*, etc, on the other hand, which have an a→e alternation, no shortening is observed, e.g. *schlägt*, *rät*, etc. which has long [e:] or [ɛ:]. Shortening only occurs when the root ends in an obstruent.¹⁴ The empirical generalization is under (14).

- | | | |
|------|--|---|
| (14) | <ul style="list-style-type: none"> • Alternating verbs of the a-e class do not display shortening • Alternating verbs of the e-i class display shortening (if the root ends in an obstruent) | <i>schl[a:]gen</i> – <i>schl[e:]gt</i> ,
<i>r[a:]ten</i> – <i>r[e:]t</i>
<i>g[e:]ben</i> – <i>g[i]bt</i> ,
<i>tr[e:]ten</i> – <i>tr[i]tt</i> |
|------|--|---|

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

3 Background

In their discussion of apophony, Ségéral & 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 (Kaye et al. 1985; Harris 1994; Backley 2011), we can represent this as in (15).¹⁵

- | | | | |
|------|--------------------------------------|------------------------------------|--|
| (15) | <i>binden</i>
b • n d-

 I | <i>band</i>
b • n d-

 A | <i>gebunden</i>
b • n d-

 U |
|------|--------------------------------------|------------------------------------|--|

We treat these three root forms as lexically related, not morphologically derived, and assume their elements to sit on the E1 tier.

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 (16), where the parasitic element is |A|, realized on another tier (see also Postma 1996, 2014). 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.

- | | | | | |
|------|--|--|--|--|
| (16) | “parasitic element”
 A

h • lf

ablaut
 I | <i>helfen</i>
 A

h • lf

 A | <i>half</i>
 A

h • lf

 A | <i>geholfen</i>
 A

h • lf

 U |
|------|--|--|--|--|

¹⁴ Shortening is not present in for instance: *l[e:]sen-l[i:]st* ‘read’, *s[e:]hen-s[i:]ht* ‘see’. In terms of Element Theory, shortening depends on the presence of |ʔ| in the subsequent consonant.

¹⁵ For reasons of elegance, skeletal vocalic grid points are indicated with •. This is equivalent to the V or X in the earlier templatic literature.

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.¹⁶ Just as in the case in the previous section, we assume that these two levels represent *two different tiers* with distinct properties, the E1 tier and E2 tier, as in (17).

(17)

	<i>helf-</i>	<i>half-</i>	<i>holf-</i>
E2 tier	A	A	A
	h • lf	h • lf	h • lf
E1 tier	I	A	U

This parasitic element on the E2 tier has a relation with the suffix: the |A| in (17) originates from a suffix, which contained [a], e.g. OHG 13pl present tense *helf-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*.¹⁷ It also shows that, synchronically, 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 *helf* were the base form, we would expect the ablaut sequence *helf-half-hulf*, counter to fact.

(18)

	<i>schlafen</i>			<i>helfen</i>		
1SG	schlafe	[a:]	A	helfe	[e]	I + A
2SG	schläfst	[e:]	A + I	hilfst	[ɪ]	I
3SG	schläft	[e:]	A + I	hilft	[ɪ]	I
1PL	schlafen	[a:]	A	helfen	[e]	I + A
2PL	schlaft	[a:]	A	helft	[e]	I + A
3PL	schlafen	[a:]	A	helfen	[e]	I + A

Notice that *addition* of |I| (i-umlaut) and *subtraction* of |A| in (18) pattern as if they were one and the same morphological process in synchrony. Hence, we must generalize over I-addition and A-subtraction in the 23SG forms of the present tense paradigm.

In the next section we expound our model in an axiomatic way. It might be skipped on first reading and be used under backtracking, although we recommend to study it, perhaps after having seen it operational in section 5 and further.

4 The Competitive Tier Model: Competition and coalescence in 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 develop a model¹⁸ that adopts a competitive tier hypothesis, next to the well-known coalescent tier, and next to various standardly adopted phonological principles. This paper is not a new phonology. It is a model. It is an

¹⁶ A-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 5.6 and 10.2.

¹⁷ A-umlaut only happened in specific verbs. |A|-spreading only happened if the verbal stem is not a phase and the coda does not block it: e.g. strong verbs with r and l clusters.

¹⁸ This is an axiomatic implementation of my earlier paper “The Competitive Tier”. It is the fortunate result of the many questions of three demanding but constructive reviewers. This section can be skipped upon first reading.

operational model of the two-tier hypothesis, a “pseudo code”, i.e. we also give a place to extant phonological principles, mostly with a twist, not for the sake of modifying them, but in order for the principle(s) to get implemented in a consistent way. Our intention has been to stay as close as possible to the principles and insights of modern rule-based phonology.

We take Element Theory as a starting point (Kaye, Lowenstamm & Vergnaud 1985; Backley 2011). Element Theory is a theory of phonological features that are strictly mono-valued (“privative”): elements can be there or there is nothing, i.e. no negative values. As we mainly discuss vowels, we focus on the space spanned by place features. For further reference, we list some place features under (19). Vowels are built up by the basic features |A|, |I|, and |U|. An extra element |@| is assumed that functions as a neutral element under (19)f (Harris 1994; Van Oostendorp 2005), discussed in section 7. In isolation, |@| has [ə] as its exponence. Finally, we assume floating features (Lodge 1986; Wiese 1996), e.g. the umlaut factor |I|, illustrated under (19)g, notated as a *fraktur* character \mathfrak{I} .

(19)	•	•	•	•	•	•	≠	≠
	A	I	U	A + U	A + I	@	I	@
	[a]	[i]	[u]	[o]	[e]	[ə]	\mathfrak{I}	[ə]
							(floating)	(when licensed)
	a.	b.	c.	d.	e.	f.	g.	h.

A floating element lacks an active prosodic anchoring point of its own (because of its lexical specification). Such a melody without prosodic space is in search of space to realize. This is parallel to Rubach’s 1986 theory of yers as vowels that are not connected to a unit of prosody.¹⁹ Notice that we don’t assume the floating nature to reside in a delinking process, as under (20)a. The deactivation resides in the nature of the grid point, as in (20)b. The model-theoretical reason is that 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, (20)c. Furthermore, all processes are defined on grid points and executed on the distinct tiers, rather than being independent tier processes. It is the more restrictive option in a model with two tiers. There is also a principled reason: association lines are part of the productive phonological calculus, while the nature of the grid point belongs to its lexical specification.

(20)	a. Delinking	b. This model	c. This model
	•	≠	Y
	≠		
	X	X	≠
			Tier 2
			Tier 1
			X

Elements are associated to grid points according to alignment, which operates Edge-In (Yip 1988), i.e. from the affix inward. In the cases we consider here, it will be mostly right-to-left. Finally, we assume that only the element that is underspecified, |@|, may stand on a deactivated grid point, provided that it is licensed (see below). This is represented in (19)h. A deactivated grid point is a weak position that resists hosting elements that are phonological complex (see below for a definition), and hosts only dependent elements (Walker 2011).

¹⁹ 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.

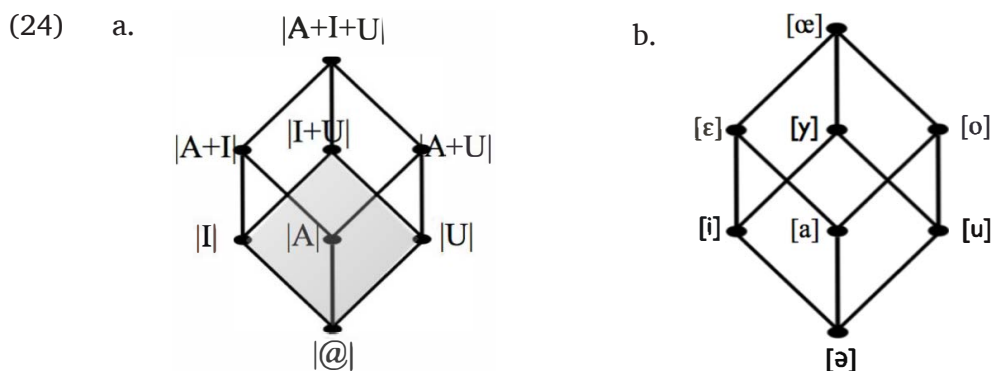
Element Theory (ET) is a calculus of elements which is basically standard set theory. Segments are *sets* of elements. ET assumes that elements do not constitute the sounds themselves but are (*place*) *operators* working on grid points, thus producing a grid point with segmental exponence. For instance, the element $|U|$ working on a grid point \bullet , is assumed to produce $[u]$. We use the standard notation $|U|-\bullet$. Similarly, $|I|$ and $|A|$ produce $[i]$ and $[a]$, respectively, when working on a grid point. $|A|$ and $|I|$ working together on \bullet produce $[e]$, etc. In ET, the sound $[e]$ is more complex than $[i]$ or $[a]$, while $[\text{œ}]$ is the most complex of all vowels. We here elaborate an implementation of the place features in ET as a (semi)-lattice, i.e. we implement it along the lines pursued in Harbour's (2014) theory of number features. Element composition creates a mathematical structure known as a bounded *join semi-lattice*. On full lattices, two basic operations are defined, JOIN (or “union”) and MEET (or “intersection”) being the only connectors that are operative on lattices. Empirically, we need JOIN to capture the anchoring of floating elements, e.g. i-umlaut, producing $[e]$ out of $[a]$. We need MEET to account for reduction phenomena, e.g. schwa formation. In the standard (and most simple) realization, JOIN (+) and MEET (.) are commutative, (21)a and (22)a, as well as associative. MEET has $[\text{œ}]$ as its neutral element. JOIN has $[\text{@}]$ as its neutral element, as in (21)–(22).

- | | | |
|------|---|---|
| (21) | a. $X + Y = Y + X$
b. $X + \text{@} = X$ | commutativity of JOIN
neutral element of JOIN |
| (22) | a. $X . Y = Y . X$
b. $X . \text{@} = \text{@} . X = \text{@}$
c. $X . 1 = 1 . X = X$
d. $X . (Y + Z) = X.Y + X.Z$ | commutativity of MEET
neutral element of MEET ($1 = \text{œ}$)
associative property |

These axioms produce the following laws, which we here list for future reference.

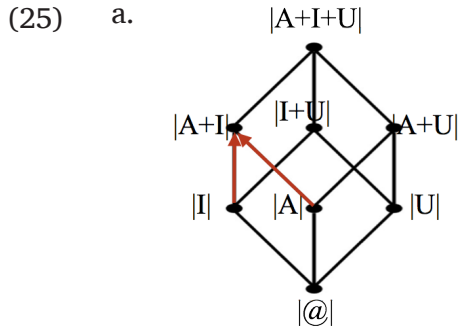
- | | | |
|------|--|----------------------------------|
| (23) | a. $(X + Y) . X = X$
b. $(X . Y) + X = X$ | absorption law
absorption law |
|------|--|----------------------------------|

The subsequent application of MEET X and JOIN X (in either order) on Y produces absorption of Y, as the *absorption laws* in (23)ab show.²⁰ 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 well-known mathematical pattern that is called a *lattice* (Partee, Van der Meulen & Wall 1990: 277ff). The lattice structure can be (incompletely) represented in a Hasse diagram, given under (24)a and its exponence counterpart in (24)b.

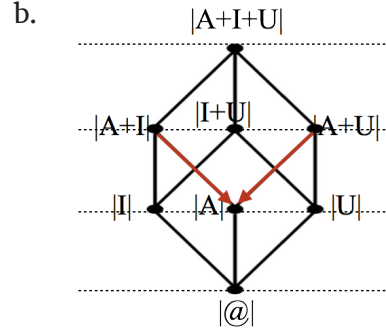


²⁰ An anonymous reviewer suggests to exploit this algebraic relation as a model of expulsion. If we follow this intriguing suggestion, absorption might arise upon alignment in an ambiguous stress context, i.e. whenever both (27) and (28) apply. We leave it for further study.

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 (25)a. When one goes down, one follows the meet connector, e.g. MEET of $|A+I|$ and $|A+U|$ is $|A|$, i.e. $|A+I| \cdot |A+U| = |A|$, illustrated under (25)b.



Red arrows represent JOIN



Red arrows represent MEET

Disjoint sets produce the neutral element, $@$, 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. $|X| \cdot |Y|$ (ultimately) produces the bottom node $|@|$. Without the element $|@|$, the set of elements would not be bounded under MEET. In the lattice approach, every element of the lattice is a singleton, the seemingly complex nature of $|A+I|$ is only mnemonic.²¹ It is the *lattice* that hosts the structure and the relations between the elements define complexity. Complexity is not stated in the number of elements, as the number is not a constant, e.g. $\{I\} = \{I, @, I, I\}$. Complexity is stated with respect to the horizontal dashed planes in the Hasse diagram under (25)b. In this sense, $|@|$ is the element with lowest complexity.

There is a well-known relation between stress and vowel complexity, in the sense that stress tends 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 cannot carry the stress on its own, 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 $|@|$ being *stress-licensed*. A formal definition is given under (26). It captures the fact that schwa is parasitic on another stressed vowel: $|@|$ 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 in the sense of Lowenstamm, i.e. when it is in another morphosyntactic phase than the stress.

(26) **Schwa Licensing**

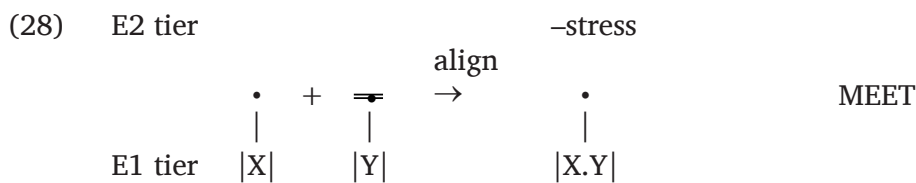
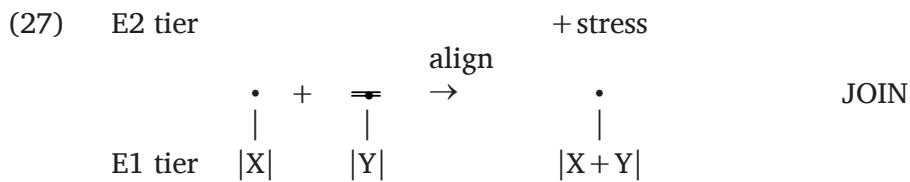
$|@|$ is licensed iff $|@| \dots$
 is associated to a grid point with stress or is adjacent to the stress.²²

²¹ For instance, the inclusion relation, which will be important later on, e.g. $P \subset Q$, with $P = |X|$ and $Q = |X+Y|$, should be formally defined as $P \subset Q \leftrightarrow P+Q = Q$, not on the “components” of P and Q : $|X| \subset |X+Y|$, which is taken as a consequence.

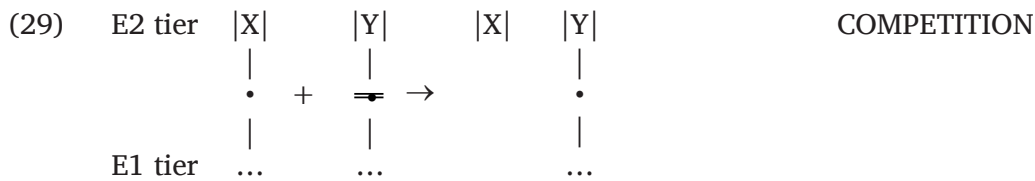
²² An empirical and theoretical underpinning of the relation between stress and the strong/weak opposition in verbs is given in Postma (2002: 236–239).

Spreading/alignment, being ways to establish licensing, typically occurs in strong verbs (whose roots are not phases), the second way (adjacency) is with weak verbs (whose stems are phases, discussed in section 5.4).

We further define *when* the two operations MEET and JOIN operate. We assume a deterministic model where the structure defines which operation is active. On the E2 tier, elements are in competition i.e. they do not operate on each other: one expulses the other. The competitive nature of the E2 tier implies that JOIN and MEET both operate on the E1 tier. We assume that they operate depending on stress. Taking into account the relation between stress and complexity and the relation between destressing and neutralization (Trubetzkoy 1969), we adopt (27)–(28).



For the sake of completeness, we repeat under (29) how alignment proceeds (here: from right to left), first the anchoring of the rightmost |Y|, while |X| remains without prosodic space. |X| is not deleted (i.e. no stray erasure, Steriade 1982) or “overwritten” but remains without exponence when lacking a grid point.

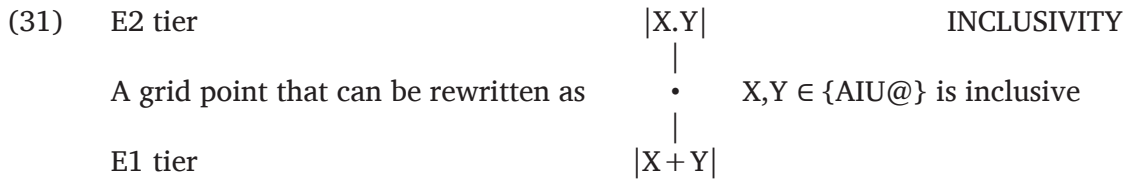


A stray element only leads to well-formedness when it occurs at the edge (#) of the spellout domain (Goldsmith’s 1990 extrametricality), i.e. expulsed elements are only allowed at the edge of a parsing domain, i.e. when extrametrical. We capture this under (30).²³



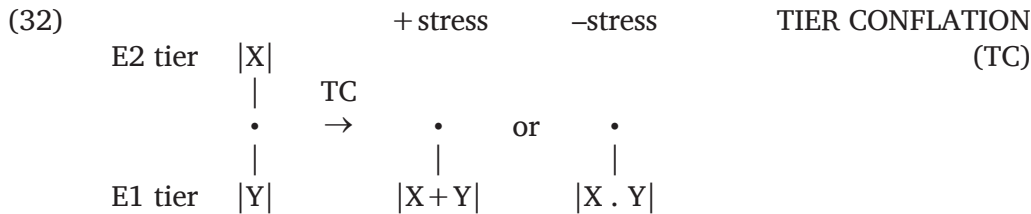
A formal relation that is important whenever the E1 tier and E2 tier interact, is *inclusivity*, i.e. whether the element on the E2 tier is included in the content of the E1 tier. Because of the universal inclusion relation on lattices $|X.Y| \subset |X+Y|$ for any pair (X, Y), we define *inclusivity* under (31).

²³ A similar requirement is, mutatis mutandis, assumed upon left-to-right alignment.



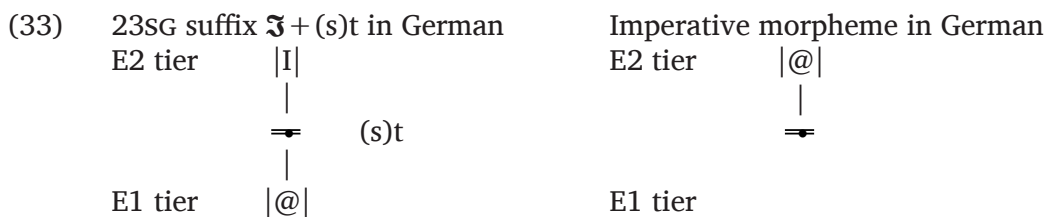
A grid point that is not inclusive is called exclusive. This concept is relevant in most interactions that involve interpretation upon spellout, such as the lax-tense opposition, the short-long opposition, schwa epenthesis, Tier Conflation, etc., as we will see.

There is an optional procedure of *Tier Conflation* (TC) upon spellout (McCarthy 1986) or, in a more modern formulation, upon closure of a phase (Lowenstamm 2010; Creemers, Don & Fenger 2016). Logically, there are two possibilities: conflation towards the E1 tier or conflation towards the E2 tier. The former possibility, conflation to the E1 tier, leads to coalescent forms. The latter leads to competition and element expulsion. We do not discuss the latter in this paper. When we speak of Tier Conflation in this paper, we simply mean conflation to the E1 tier, as represented under (32). Fully in line with (27)–(28), we leave it as a function of the stress whether it is MEET or JOIN that instantiates the conflation operation.



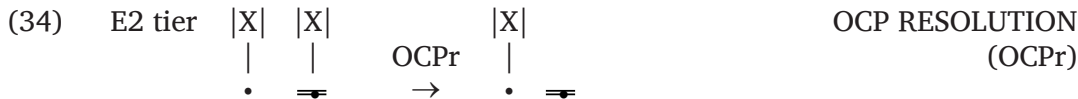
Tier Conflation (TC) is not an operation on elements but on grid points, as (32) indicates, i.e. there is no TC of an element without a grid point (stray element). Furthermore, TC only applies if the configuration allows for it, i.e. when the resulting configuration does not become illicit. Two restrictions hold. First, TC may not disrupt existing alignments. This has as a consequence that TC either applies on all or no grid points within a phase. The presence of an expelled element, therefore, blocks TC and triggers phonetic analysis of the full tier structure rather than the conflated structure. The second restriction on TC is that inclusive grid points, i.e. when the E2 material is included in the E1 material, resist application of TC, because it would imply loss of information (“Full Interpretation” or “Containment”). For instance, the grid point $|I| \text{---} \cdot \text{---} |I|$ cannot conflate to $\cdot \text{---} |I|$, but $|A| \text{---} \cdot \text{---} |I|$ may conflate to $\cdot \text{---} |A + I|$.

We symbolize the umlaut factor with a *fraktur* character \mathfrak{I} , and assume a structure as under (33) for German, which includes a floating umlaut factor $|I|$ on the E2 tier and $|\text{@}|$ on the E1 tier. The empirical justification is postponed to section 5.3. We also added the imperative morpheme.

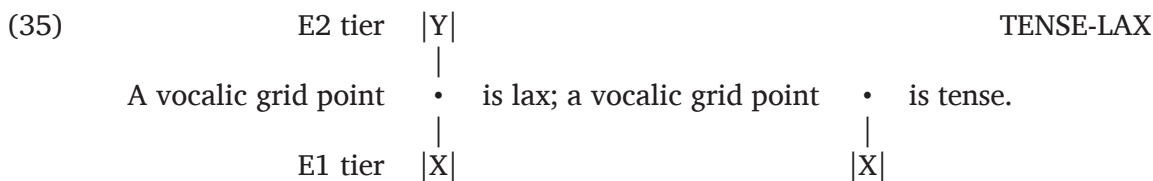


We follow Leben (1973), Goldsmith (1976), McCarthy (1978) and assume the Obligatory Contour Principle (OCP), which penalizes two adjacent identical elements on one

tier, and provides a resolution at the same time, given under (34). Notice that we take the OCP to be defined on the E2 tier (it is not active on the E1 tier because of the idempotence of JOIN and MEET) and, hence, is defined in function of at least one grid point.²⁴



In order to handle the shortening riddle, we define the lax/tense dimension.



We elaborate the lax-tense dimension in section 7 especially its dynamic nature vis-a-vis Tier Conflation.

A brief discussion of the inflectional morphology cannot be omitted, as umlaut is sensitive to different morpheme boundaries, traditionally indicated by + and #. We here assume the phase-theoretical approach to morphological domains, as elaborated for derivational morphology in Creemers, Don & Fenger (2016), henceforth CDF. Building further on Borer (2005), Marantz (1997), Embick (2010) and, most notably, Lowenstamm (2010), CDF assume, apart from *root affixes*, affixal cyclic heads: the *first cyclic head* or simply first head (F1) is special, not by definition but by consequence of the theory: it may influence spellout, stress, and meaning of the root domain, while further heads (F2, etc.) cannot, because their complement is impenetrable. This classification of heads is not a stipulation but it follows from the principles under (36).

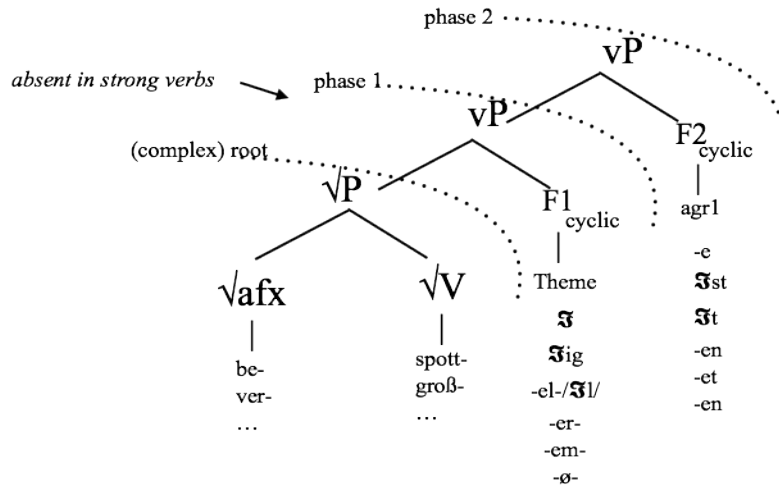
- (36) • Lexemes and affixes are roots,²⁵ be they unbound (*spott-*) or bound (*be-*). Roots may combine and form complex roots, such as the root phrase √P (*bespott-*).
 • Head affixes (“cyclic functional heads”) mark potential phase boundaries.
 • When a cyclic head x is merged, cyclic domains in the complement of x are spelled out (Embick 2010: 51).
 • Spellout = linearization/concatenation + phonological calculus

The “phonological calculus” in the fourth dot of (36) refers to the processes we discuss in this study: alignment, spreading, tier conflation, etc. The rules under (36) imply that these phonological processes cannot operate across a phase. The principles under (36) are exemplified under (37) with a maximally articulated verb like *vergrößern* ‘to amplify’ or *bespötteln* ‘to mock repeatedly’. The root AFX and/or the cyclic head F1 may be absent or without lexical material.

²⁴ OCP resolution with two active grid points is, therefore, blocked in the phonology. Resolution with two active grid points seems to be limited to the lexical phonology, e.g. in contexts with ablaut *leiden-litt*, where it triggers shortening.

²⁵ 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 5.4.

(37) Illustrative structure of *bespöttelt* ‘(he) mocks repeatedly’ and *vergrößert* ‘increases’



Let us follow the construal bottom-up. First, one or more roots are combined into a complex root phrase, indicated by \sqrt{P} . Upon subsequent merger of the cyclic head F1 (empty or filled with e.g. – $\mathfrak{F} + l$ -, $-el$ -, etc), the lower domain is checked for spellout. In this case, no spellout occurs because no cyclic head is probed in the complement of F1. Upon merger of the next cyclic head F2 (filled with $agr1$), the lower cyclic domain *be + spott + $\mathfrak{F}l$* is spelled out. Within this phase, an occasional umlaut factor in the theme head F1 can modify the root: *bespöttel*-, *vergröß*er-. The umlaut factor present in 23SG agreement affixes ($\mathfrak{F}st$), on the other hand, cannot change the spellout of F1, which becomes visible in, say, *brumm + el*- in *brummeln* ‘to mutter’ without umlaut, which does not change to *brümmeln* in 23SG, because the affix is outside the phasal boundary (“weak verb” cf. Kayne 2016). We discuss in section 4 how floating umlaut material is handled in these cases. In strong verbs, say *(be)schlafen*, the derivational cyclic head F1 is absent and the agreement affix, being the first cyclic head, can change the spellout of the root, e.g. umlaut applies in 23SG present tense $\mathfrak{F}(s)t$. The existence of a projection F1 (“theme”) thus safeguards the integrity of the verbal root from being affected by the agreement affixes. There is a second effect of the phasehood of the F1 domain: the spellout of F1 makes agreement markers in F2 adjacent to the stem in weak verbs, while this is not the case in strong verbs, where adjacency is not defined (yet). Phasal spellout of a domain captures the existence and distribution of a phonological word boundary #. This is the only morphological ingredient we need in this basically phonological model of root alternations.²⁶

This finishes our axiomatic overview. In the next sections we apply competition and coalescence of elements to capture 1. alternating verbs, 2. the imperative conundrum, 3. the epenthesis conundrum, and 4. the shortening conundrum.

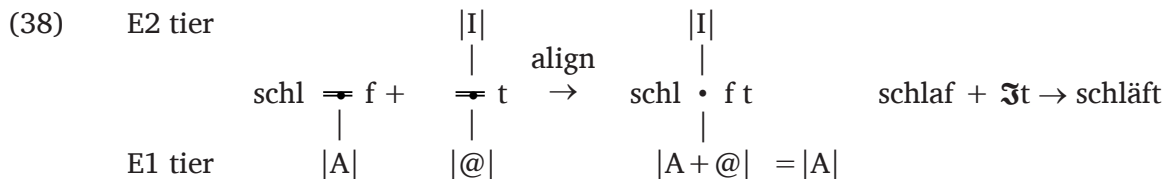
5 Application of the model

5.1 Alternating verbal paradigms

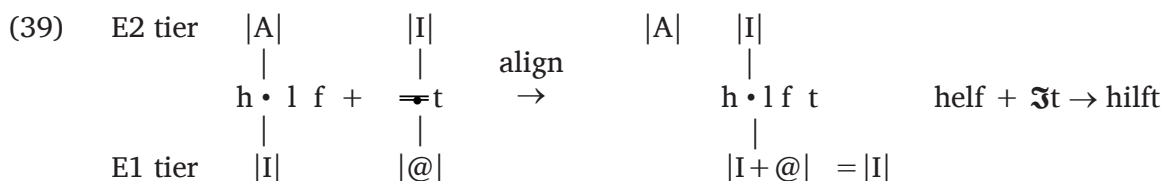
In this section, we apply the model developed above to the problem of the alternating verbal paradigms, i.e. vowel alternation in the strong verb class present tense. It explains the alternation such as *ich schlafe – er schläft* ‘I/you sleep’, and *ich helfe – er hilft* ‘I/he helps’. After our preparatory work, the calculus is rather straightforward. The representations of the two verbs become as under (38)–(39). Upon morphological concatenation of root and

²⁶ For the sake of exposition, we give the simplified model of Creemers et al. (2016), instead of the more dynamic proposal in Lowenstamm (2010). The reader is recommended to get back to Lowenstamm’s theory to fully understand the relation between prefix, verbal root, and further derivational material.

the floating 23SG suffix, realignment takes place. The scheme ignores vowel length, which will be discussed in section 7.



In the case of *helfen*, the root lexicalizes both the E1 tier and the E2 tier because of the historical A-umlaut, cf. (16).



Some comments are in place. Under (38) 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 E2 tier, which is competitive, but this property is vacuous in the case of *schlafen* ‘to sleep’ and *raten* ‘to guess’, as the root’s E2 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 [e]. The |@|-element on the E1 tier coalesces with the material present.

Let us now look at the more challenging case of *helfen* ‘to help’, a verb which had, historically, A-umlaut (< *hilfan*). 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 E2 tier nature. We then have the structure in (39). Now, consider what happens if we add the same suffixal floating |I|-element of 23SG present tense. As it is an E2 tier element, and since E2 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. Expulsion (of |A|) is the CTM counterpart of Stray Erasure (Steriade 1982). This generalizes over the two paradigms in (18). Notice that (38) is in line with the rather standard assumption that umlaut is a floating coronal feature that must spread to the stem (Hermans & Van Oostendorp 2008; Trommer 2010).

5.2 Application to the imperative conundrum

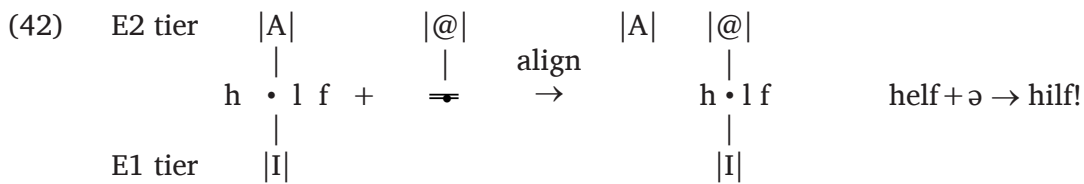
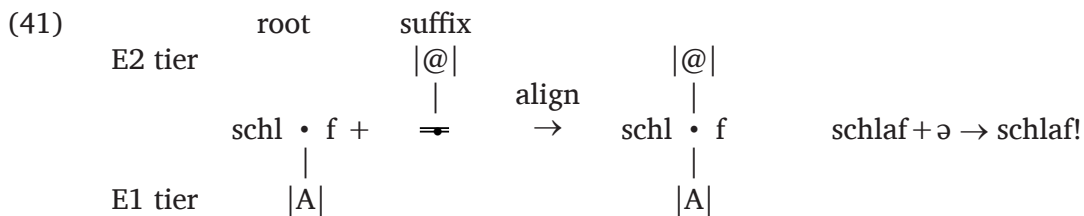
Let us now apply the model to the *imperative conundrum*, given in (11), repeated here as (40).

- (40) 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 root vowel as well as the choice of the ending. From a historical point of view, the shape of the stem is perfectly understandable: the

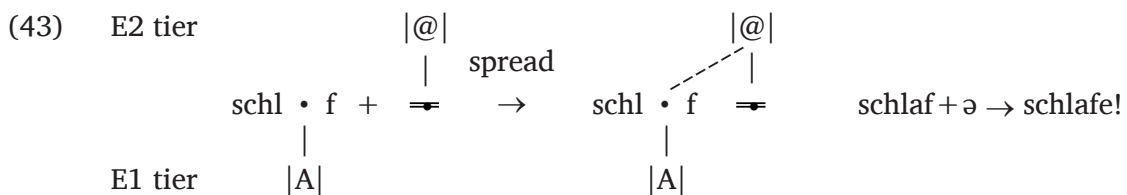
imperative takes the verbal bare root + imperative suffix, i.e. it lacks both the suffixal |I|-element in the *rate* – *rätst-rät* class, resulting in *rat!*, and it lacks the (originally suffixal) |A|-element in *helfen*, resulting in *hilf!* So, from an historical perspective, there is no conundrum. 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 E2 tier. 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 imperative schwa is added. In (41)–(42) we represented the alignment strategy of root and floating suffix.

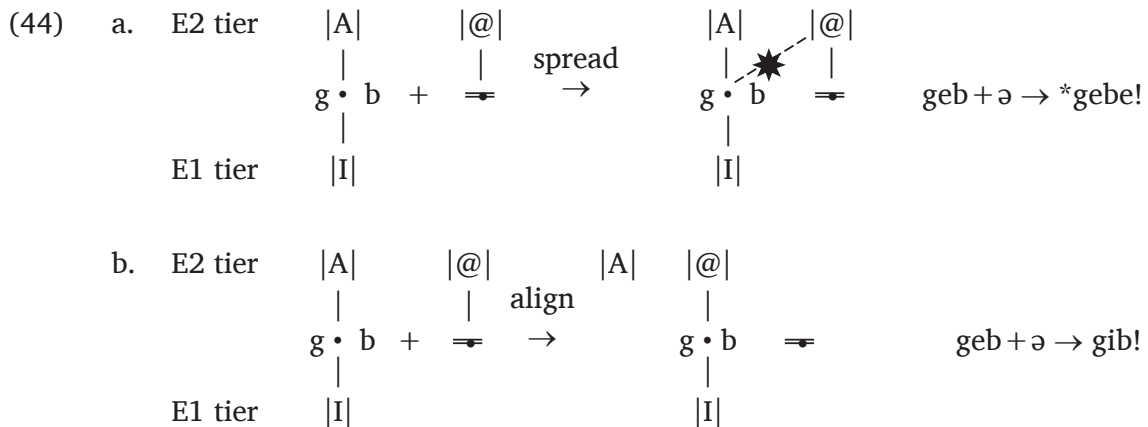


For /a/-stem verbs such as *raten* ‘to guess’ and *schlafen* ‘to sleep’, etc, |@| simply realizes on the E2 tier of the verbal root. No element is present on this tier and so, there is no problem in this case. The more interesting case is the A-umlauted verbs. As this |A| is synchronically part of the stem as an E2 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.

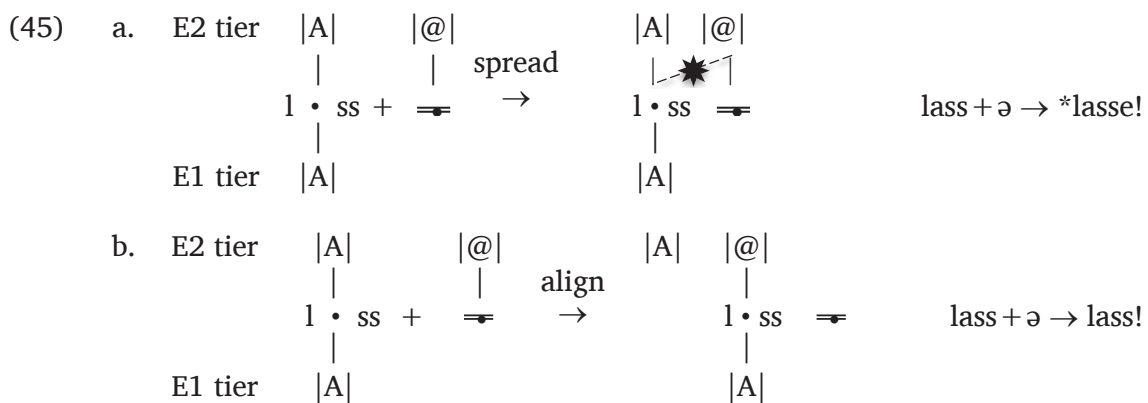
In (43)–(44), we analyze the (older) variants with spreading of |@|, *schlafe!* and **gibe!*. The spread variant, though slightly stilted in modern German, is without problem in the case of *schlafen*, because there is no element on the E2 tier. In the A-umlauted class, spreading is simply not invoked 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 associated with two E2 tier elements. These spread variants are indeed absent: **hilfe!*²⁷ ‘help.IMP’, **gibe!* ‘give.IMP’, **tritte!* ‘step.IMP’.



²⁷ Though possible as a noun: *Hilfe!*.



This solves the imperative conundrum. Notice that the system allows for a combination of the strategies in (43) and (44)b with a double |A| on V1- and E2 tier, as in (45).



This option is realized in the verb *lassen* ‘to let’ (and *fallen* ‘to fall’ for modern 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 E1 tier and E2 tier in *lassen* ‘to let’.

5.3 Application to the epenthesis conundrum

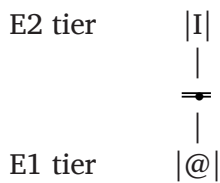
Before we apply the theory to the epenthesis conundrum, let us first give an empirical justification to our representation of the umlaut factor in (33). We take our evidence from West-Germanic dialectology. Notice first that Dutch, Frisian, Pomeranian, the Low-Saxon and Limburgian dialects in the Netherlands do not have epenthetic vowels in the contexts under scrutiny at all, and resolve the -t + t-clash by degemination (Booij 1995: 68) or — as happens in the Low Saxon dialects of Twente — by simply having 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).

(46) *Dialectology of epenthetic schwa in 23SG present tense in West Germanic*

Dialect Chart	+ epenthesis	– epenthesis
+ I-umlaut	High German Low German	Pomeranian Low Saxon Limburgian
– I-umlaut	X	Dutch Frisian Yiddish

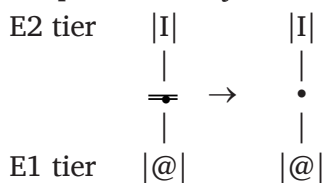
The chart under (46) shows that epenthetic schwa comes about in a subset of the languages with i-umlauting forms in 23SG present tense. In languages without I-umlaut in 23SG, epenthetic schwa is absent. This shows that schwa-epenthesis is dependent on 23-umlaut *in the language* despite the fact that 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 23SG morpheme, i.e. \mathfrak{J} , unless the melody has incorporated into the verbal stem upon alignment. It points to the structural identity of the possibility of umlaut and the possibility of schwa epenthesis. This suggests the following Element-Theoretical implementation of umlaut in the Competitive Tier Model: a floating $|\@|$ on the E1 tier with an $|I|$ -coloring on the E2 tier, cf. (47).

(47) Umlaut suffix \mathfrak{J} in High and Low German



Now, one might be tempted to formulate epenthesis as a rule under (48), which activates the grid point.

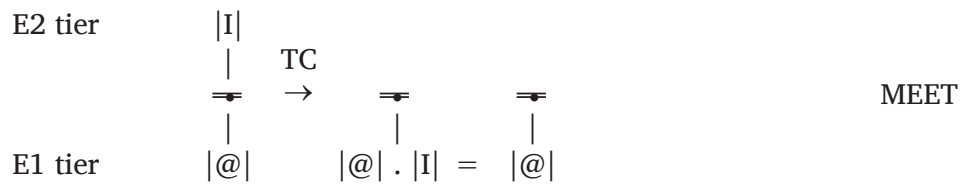
(48) Epenthesis (rejected)



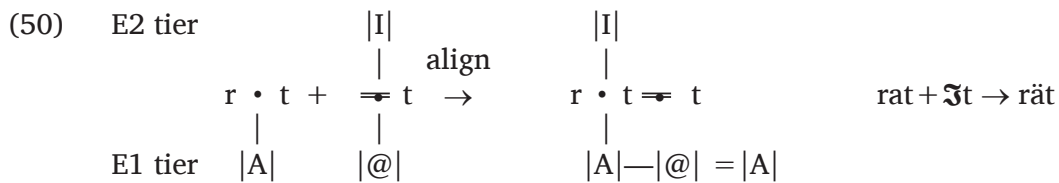
However, this cannot be correct because it would provide $|I|$ with prosodic space and removes its floating nature. Moreover, changing an underlying gridpoint is not part of our synchronic productive phonological toolbox. Instead, we retain the deactivated grid point \equiv and make the assumption that epenthesis in German is not truly an independent process, but is a consequence of tier conflation, defined under (32) and applied to umlaut under (49).²⁸ Because the floating position is without stress, MEET applies.

²⁸ As correctly observed by one anonymous reviewer, we should ban the word *epenthetic* for these cases: the structure belongs to the underlying representation. Nevertheless, we maintain the word as referring to what happens at the surface.

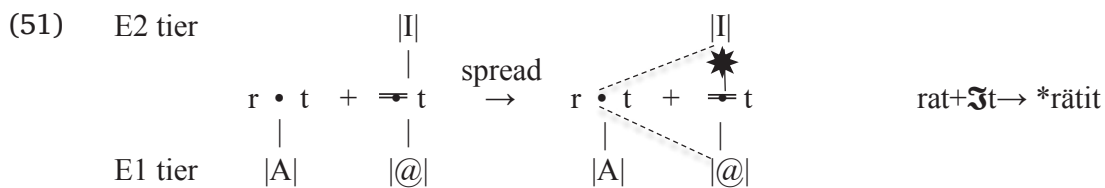
(49) *Epenthesis = Tier Conflation operating on a deactivated grid point*
 – stress



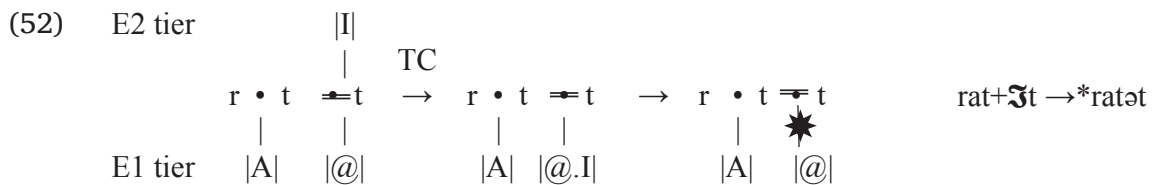
As we have shown in section 1, verbs with I-umlaut (*raten* ‘to guess’, *lassen* ‘to let’), and verbs with A-umlaut (*geben* ‘to give’, *treten* ‘to step’, etc.) have the |I|-element in the ending, i.e. it is $\mathfrak{I}+t$ and $\mathfrak{I}+st$. The representations are given under (50)–(52). The alignment structure is in (50).



The spreading configuration is under (51). This produces an ill-formed structure as |I| may not sit on a deactivated grid point, cf. section 4.

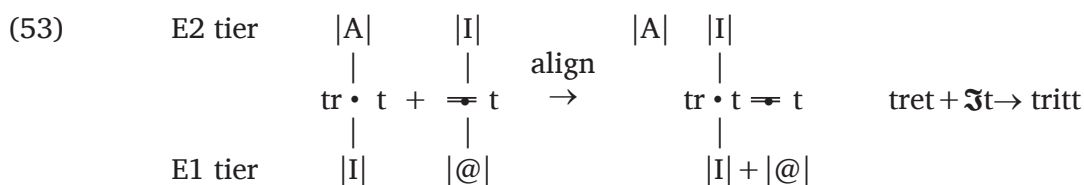


The structure would become (52) upon tier conflation.

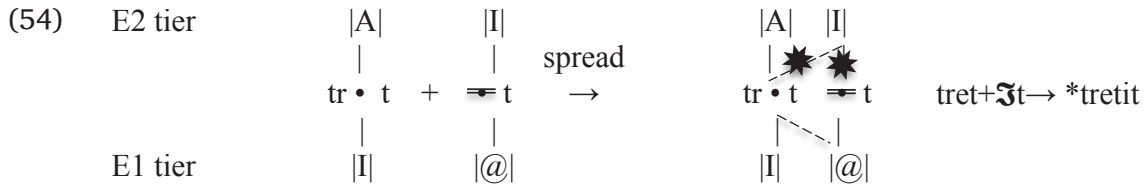


This structure is ill-formed, too. The reason is that an |@| is only licit on a deactivated grid point if it is licensed, i.e. situation (19)h. However, strong roots do not form a phase and adjacency is not defined. Only full alignment starting off at the first active grid point in (50) creates a well-formed structure.

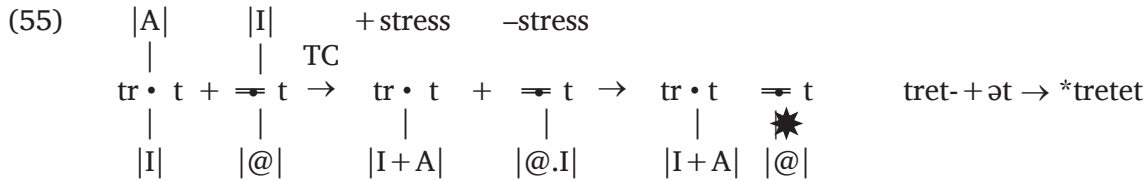
Similar relations hold in the a-umlaut class. As we have seen, these have i-umlaut as well. |A| sits on the E2 tier while |I| sits on the E1 tier. The representations are under (53)–(55).



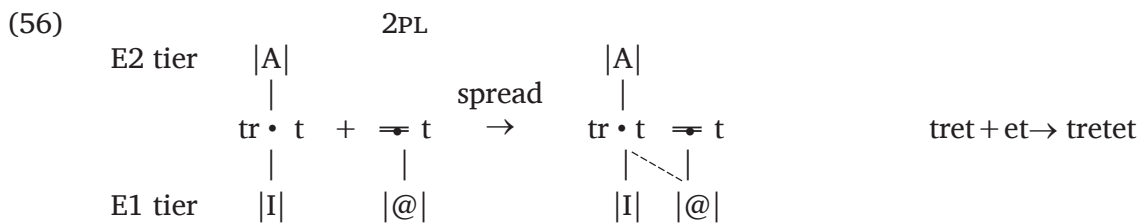
Spreading is not possible, as represented under (54), because of a two-fold ungrammaticality: the structure violates the competition on the E2 tier. Furthermore, |I| may not sit on a deactivated grid point.



Let us finally discuss tier conflation. This process gives rise to the ungrammatical (55). As *treten* is a strong verb, its root is not a phase. Hence licensing of schwa by adjacency is not possible because adjacency is not defined.



Notice that there is no conundrum in second person plural present tense. The forms are *ratet* and *treten*. We only have to assume that the 2PL suffix has no umlaut factor, only '|@| + t' on a deactivated grid point on the E1 tier. The analysis for *treten* is given under (56). The analyses for *ratet* ‘you.PL guess’, as well for non-epenthetic forms such as *spielt* ‘you.PL play’ are mutatis mutandis.



In the next section, we apply the analysis to weak verbs, and show why these do show epenthesis.

5.4 Weak verbs

Weak verbs form their past tense by suffixation, e.g. in German *-te*: *zahlen-zahlte-gezahlt* ‘to count/pay’.²⁹ Moreover, they have a deviant 23SG suffixation: they do not have umlaut, only the suffixal *-(s)t* survives in 23SG.: *er zahlt/*zählt*. Furthermore, they always have epenthesis upon root-suffix clashes: *er spaltet* ‘he splits’. Finally, weak verbs realize the imperative in *-e*: *zähle!*³⁰ The competitive tier model predicts all these deviant facts without further stipulation.

Weak verbs are derivational,³¹ be it denominal (N + F) or deadjectival (A + F), i.e. their stems are not formed by a bare root but by a root with a derivational head F1 (cf. section 4). This cyclic head is often **ʒ** (*Wahl-wählen* ‘choice-choose’, *braun-bräunen*

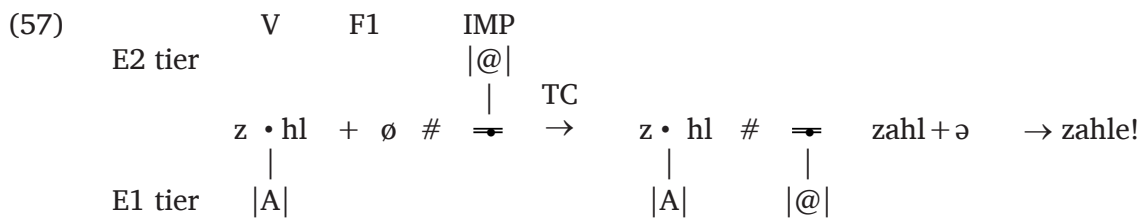
²⁹ For a uniform treated of suffixal *-te* and ablaut, cf. Postma (1997; 2014), where it is argued that *-te* is the consonantal realization of floating [I].

³⁰ In the modern spoken language, the imperative *-e* is often left unpronounced (*zahl!*). Deletion is sensitive to phonetic conditioning (e.g. *rechne!/*rechen!*). We ignore these ‘late’ effects here.

³¹ “Die meisten schwacher Verba sind Denominativa und auf diesen Denominativen beruht die Lebenskraft des schwachen Verba in der jüngeren Sprache. Aber daneben stehen anders gebildete Verba, die, wenn sie auch im Germanischen als besondere Gruppen nicht mehr hervortreten, doch um so weniger übergangen werden dürfen, als sie auf die Form der Denominativa entscheidend eingewirkt haben”. (Wilmanns 1920: 44). (...) Eine sichere Scheidung zwischen denominativen und Wurzel-Verben ist, da sie in ihrer Form nicht mehr unterschieden sind, nicht möglich (vgl. Grdr. I §176, 190).

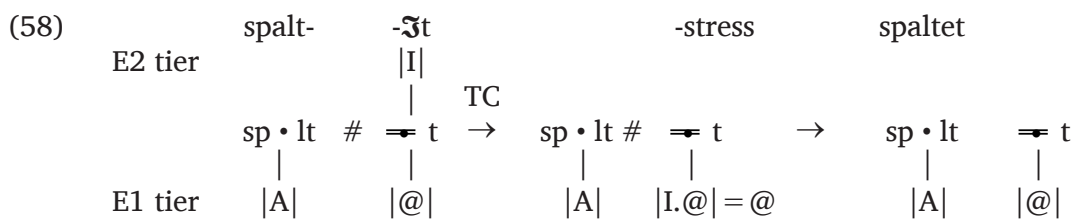
‘(to) brown’, etc.), or *-el-*, *-er-* (*plauderen* ‘to chat’), or a combination of these (*lachen-lächeln* ‘to laugh’, *stechen-sticheln* ‘to stab’). Zero derivation is possible too (*Haus-hausen* ‘house-to house’). We assume that in bare weak stems, such as *holen* ‘to take’, where no free root can be identified, this structure is abstract $\sqrt{\text{hol-}} + F_{\emptyset}$ (cf. Zonneveld 1982 for the evidence for an abstract derivational head in Dutch). Weak stems, therefore, undergo phasal spellout (Lowenstamm 2010; Creemers, Don & Fenger 2015) upon further affixing by agreement markers, as sketched in the theoretical section 4. Consequently, schwas in suffixes cannot spread to the stressed stem, but are licensed in situ under adjacency, cf. (26). Under (57) and (58), we give the analysis for the imperative suffix $|\text{@}| \rightarrow \bullet$ and the 3rd person singular present tense suffix $-\mathfrak{I}t$, i.e. $|\text{I}| \rightarrow \bullet \rightarrow |\text{@}| + (\text{s})t$.

Let us start analyzing the imperative. Spreading of $|\text{@}|$ to the stem is impossible as the stem is a phase. Staying in situ is licit under adjacency, as the stem has been spelled out. Tier conflation is licit as well. We actually think that the latter analysis is the only correct one, which is given under (57).



At first glance, spreading of $|\text{@}|$ to the stem seems to be licit because there is no material present on the E2 tier. However, spreading to the stem, being a phase, is forbidden. On the other hand, spreading to the stress is not needed because the schwa is already licensed in situ under adjacency, as */zahl-/* is a phase. This makes (57) with tier conflation the only possible analysis.

The 23SG suffixes are parallel. Alignment is not possible because the stem of a weak verb is a phase. Spreading is not possible, because $|\text{I}|$ may not sit on a deactivated grid point. Staying in situ is illicit because $|\text{I}|$ cannot sit on a deactivated grid point (*spaltit). Tier conflation is the only option.

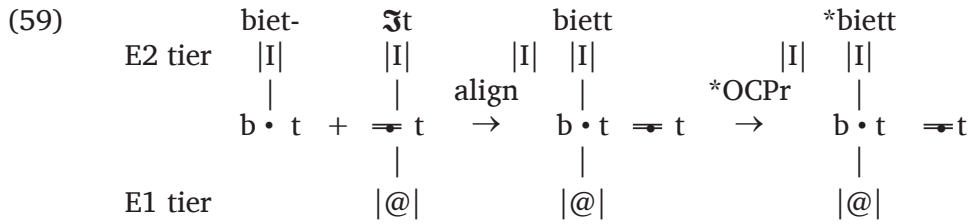


TC gives us $|\text{@}|$ on the E1-tier (under MEET because of *-stress*), which is licit on a deactivated grid point provided it is licensed. This is the case, as $|\text{@}|$ is adjacent to the stem because a weak verbal stem is a phase. An attractive feature of our model is that it generalizes over strong and weak verbs. They have the same underlying endings in the present tense, though their realization is different. This solves the epenthesis conundrum in CTM.

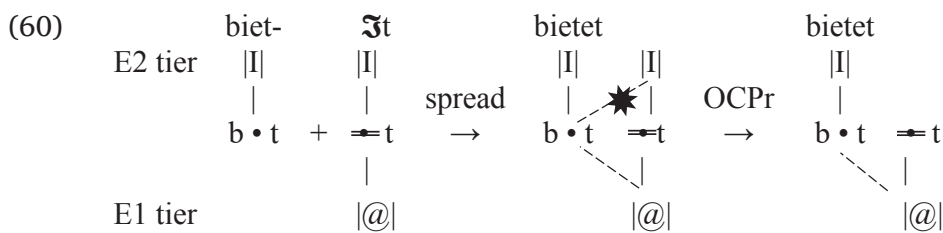
5.5 Strong verbs with epenthesis – OCP effects

Let us now observe a limited class of strong verbs that surprisingly have epenthesis in 23SG. These are typically verbs with $[\text{i}]$ in the root, be they lax or tense monophthongs (*bitten* ‘to request’, *bieten* ‘to offer’), diphthongs (*leiden* $[\text{ai}]$ ‘to suffer’), or vowel nasal combinations (*binden* ‘to bind’, *singen* ‘to sing’): they realize epenthetic (*er*) *bittet/bietet/leidet/bindet* ‘(he)

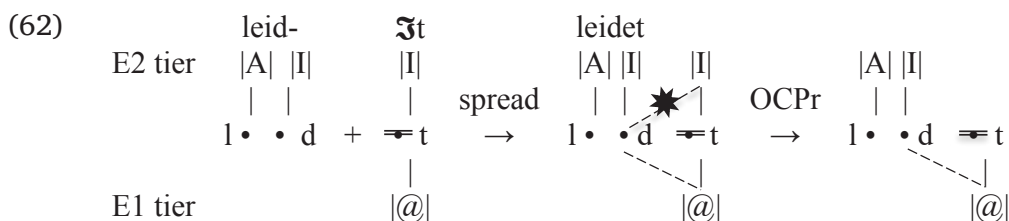
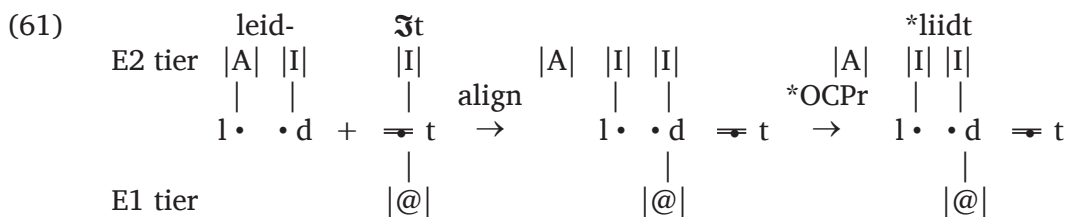
requests offers/leads/binds'. In these circumstances, there is an adjacent realization of two |I|-elements, one of the root and one of the suffix. So, we hypothesize that the Obligatory Contour Principle (OCP) is at work. Evidence for this is that heterorganic diphthongs [ai], [oi] and [ui] in other domains in the grammar, e.g. noun pluralization and diminution, are unaffected by mutation in German. Let us see how it works. Upon alignment and expulsion, as given under (59), a OCP violation is still there, as expulsion does not delete an element (no "stray erasure"). So the OCP violation is still present. On the other hand, the context of OCP resolution (OCPr) is lost, because OCP resolution makes reference to grid points, and hence does not operate on this context with extrametrical material, cf. (34).



While alignment gives rise to ill-formedness *biett, spreading gives a well-formed structure, as represented under (60). As the context of OCP resolution is present (which refers to grid points), one |I| is deleted, and we are only left with spreading |@|, which is licit: *bietet*. When the OCP works in situ, the structure becomes well-formed upon spreading.



As to the epenthetic schwa, the E1 tier is completely empty and the |@| element can spread to the root for licensing. Similar results are obtained with *leiden* 'to lead', either pronounced as [ai] or [ei]. This root with [ai] has been analyzed under (61)–(62). The [ei] dialects have an extra |I|-element on the E1 tier.³²



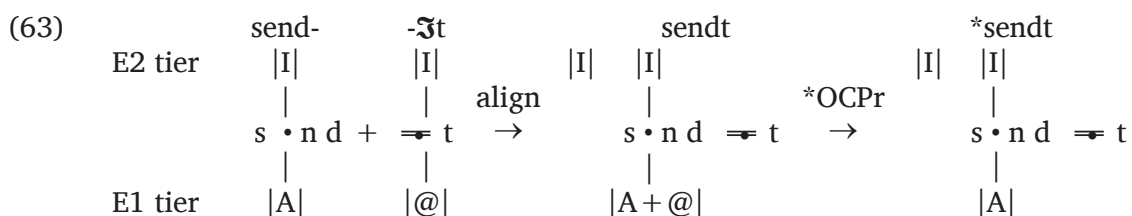
³² A problem looms upon including ablaut into the derivational system, in view of the expulsion of |A| (± shortening) upon past tense formation [ai] → [i(:)]: *meiden-m[i:]d* 'avoid(ed)', *leiden-l[i:]tt* 'suffer(ed)', which the OCP would neutralize. |A|'s expulsion might come about by |@| rather than |I|.

This shows that this strong class with epenthesis is allowed by the model by virtue of OCP resolution.

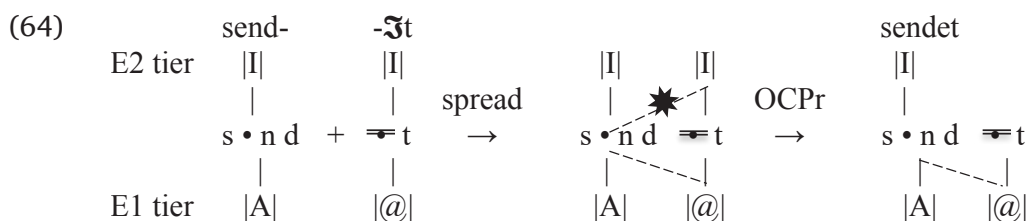
5.6 The *-jan* class (“Rückumlaut”)

There is a class of verbs in German with present-past tense vowel change (*brenn-/brann-* ‘burn’, *nenn-/nann-* ‘to mention’, *renn-/rann-* ‘to run’, *denk-dacht-* ‘to think’, ...), that belongs to the epenthetic category. These stems typically have /e/ + /n/ in the root.³³ This class includes two stems that end in a dental plosive: *send-/sand-* ‘to send’ and *wend-/wand-* ‘to 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 so called rückumlaut. Rückumlaut happened in verbs that made the present tense with *-jan* = |I| + *an*, with |I| a present tense marker, not part of the stem, and hence not showing up in the past. Traditional historical grammar has taught us that his /j/ glide in the suffix caused two changes: 1. the glide’s (floating) |I| caused umlaut of the present tense stem and 2. its consonantal nature caused gemination of the final root consonant (Vennemann 1986). Because of historical Rückumlaut, an |I|-suffix that is now reanalyzed as part of the root, and to make a contrast to the verbs like *treten*, *geben*, *nehmen* (which had A-umlaut), let us explore the null hypothesis that these root verbs have their |I| element on the E2 tier and |A| on the E1 tier in their present-day lexical specification.

Let us first consider what happens synchronically under concatenation of a 23SG suffix. Under alignment, |I| expulses the |I| element but, after expulsion, the OCP blocks this structure, while the context of OCP resolution, which refers to grid points, is lost, cf. (34) in section 4. So the OCP clash cannot be resolved under alignment. The configuration is given under (63) and predicts the result *sendt* to be ill-formed. This is a correct prediction.³⁴



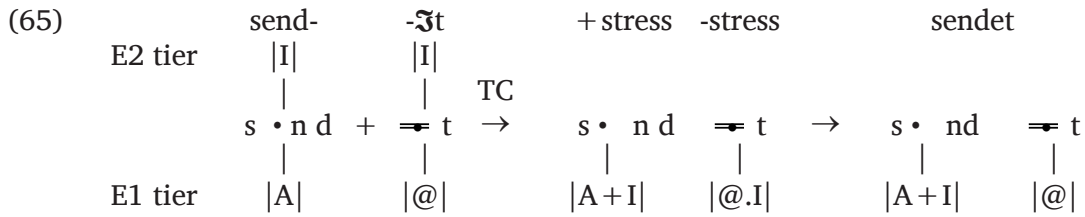
The *in situ* analysis + spreading is given in (64). In this case, OCP resolution reduces the double occurrence of |I|. This neutralizes the violation of |I| sitting on a deactivated grid point. The schwa can be licensed under spreading to the stress. The spreading strategy, which produces the existing *sendet*, is therefore predicted to be well-formed.



³³ The rückumlaut class was more extended in Middle High German (*smeck-/smac-* ‘to taste’, *setz-/satz-* ‘to put’, *hör-/hôr-* ‘to hear’, *wirk-/worh-* ‘to work’), but the /n/ roots are the only ones that survived in Standard German (De Boor & Wisniewski 1998). See also section 10 on the special status of /n/ vis-à-vis /r/ and /l/.

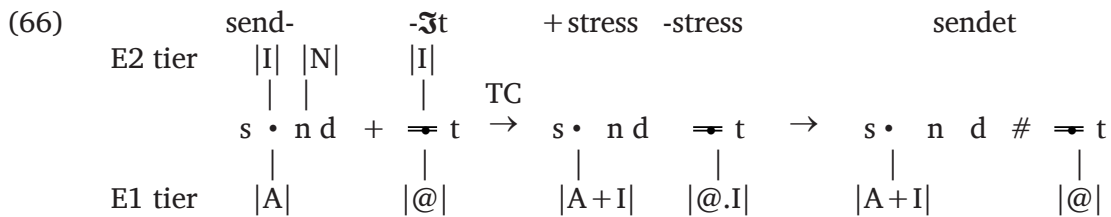
³⁴ This is an argument that competition is not *overwriting* but *expulsion*, as the OCP violation of expelled element remains active.

Let us finally check tier conflation. Inspect the structure under (65).



The theory predicts (65) 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: *senden-sandte-gesandt*. Being weak, the root is a phase because of (26), and can license the schwa in the suffix under adjacency.³⁵ So, |@| is licensed without spreading to the root. This shows that the model predicts *sendet* to be well-formed, 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.³⁶ 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 historical geminate, it is retained. Now, let us suppose that (moraic) nasals do not only have articulation on their consonantal tier (not drawn) but may also have specification on the competitive E2 tier. So let us assume that the /n/ in these verbs have |N| on the E2 tier.³⁷



This intervention has as a consequence that the OCP between the two |I|s does not apply. Moreover, the umlaut factor would cause its expulsion upon alignment, but the fact that |N| is part of a consonantal cluster or geminate resists this (Honeybone 2005). To solve this clash, TC and in situ spellout of the umlaut factor is the only option. This is only possible upon tier conflation: *senden-sandte-gesandt* must be a weak verb. (The |N| goes to the consonantal tier upon TC, not drawn.)

5.7 Strong verbs without alternation (heteroclisia)

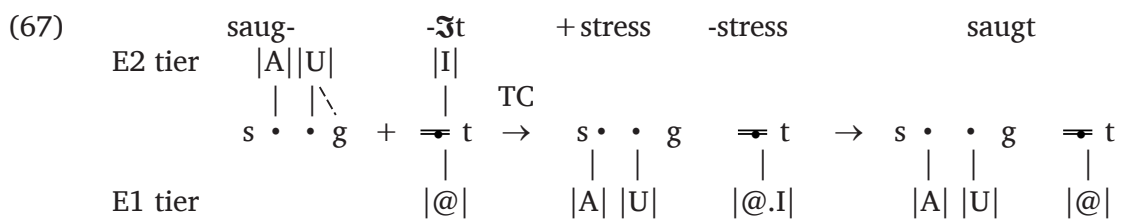
Seven ablauting verbs in German lack umlaut in the present tense: *schaffen-schuf-geschaffen* ‘to create’, *rufen-rief-gerufen* ‘to call’ and *hau(w)en-hieb-gehauen* ‘to hew’, *saugen-sog-gesaugen* ‘to suck’, *schnauben-schnob* ‘to sniff’, *kommen-kam-gekommen* ‘to come’ and *t[u:]n-tat-getan* ‘to do’. These do not have 23SG with umlaut, hence *schafft* not *schäftt*, *tut* not

³⁵ A domain cannot be a phase and not-a-phase, obviously. This implies that an extra head must be present, which is either zero, or coincides with part of the stem, say, that *sen-* is the root and *send-* the weak stem.

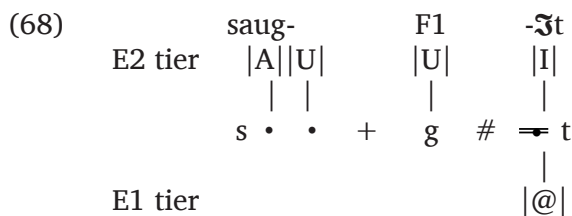
³⁶ The class with rüchumlaut was expanded in English (e.g. *tell-told*, *sell-sold*) and became prolific in Low Saxon, e.g. in the dialect of Ravensberg (Jellinghaus 1885).

³⁷ Standardly used manner elements are |ʔ| – stopness, |h| – noise, |N| – nasality, |H| – stiff vocal cords, |L| – slack vocal cords. An comprehensive model of manner in ET is as yet lacking. An elegant proposal with 3 manner elements (headed and unheaded, 6 in total) is Backley (2010: 161) and seems to be compatible with CTM. An even more reduced system of 2 place and 2 manner elements is found in Pöchtrager (2018).

tüt, kommt not *kömmt*, etc. These seven verbs have typically two |U| elements on adjacent grid points in the nucleus, be they vocalic, consonantal, or both. We here assume the ET assumption that velars and labials carry |U| (Backley 2011: 77ff.). Apparently, such double grid points with |U| can be umlaut-blocking, “umlauthinderend” (Paul 1918: 25, Anm. 6.), “inalterable” (Hayes 1986), or with “inhibition effects” (Honeybone 2005), just like the n-geminates of the previous section. On the other hand, some other roots with double |U|, such as *laufen-läuft*, do have umlaut. This suggests that a different distribution of |U| elements over the two tiers is involved.³⁸ The OCP allows double |U| under the assumption that these two |U|s are not on the same tier, which is probably the reason why *laufen* has regular umlaut. If they are on the same tier, the OCP must have reduced it by a left-to-right spread configuration with inhibition effects. So, let us assume that in the seven deviant roots have a spread |U|s on the E2 tier by their lexical specification of their root (left to right alignment). We give a representation under (67). Apparently, realignment of spread elements is not allowed. Tier Conflation is needed to prevent realignment of the spread |U|. Notice that TC of the consonantal |U| goes to the C-tier (not drawn).

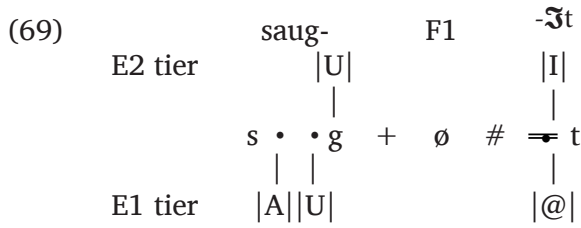


It seems, therefore, that this spread constellation realizes the same constellation that we have met under *nennen* in the previous section, where a (historical) geminate resists umlaut. The precise reason needs further study but apparently the spread element does not (re)align upon suffixation. Consequently the suffix cannot be licensed, neither under spreading nor under alignment. What is left is in situ licensing. This is, however, not possible either as long as these verbs are strong, i.e. as long as these roots are not phases. We, therefore, predict that these verbs have a tendency to become a phase, with an extra cyclic head, at least in the present tense (so-called “heteroclisis”, cf. Stump 2006: 2016). This seems indeed to be the case, with *tun* having weak *tat* in the past tense indeed, and *schnauben*, having the weak *schnaubte* next to *schnob*. Hence, in all these seven cases, a reanalysis is needed with an extra “first head” in the sense of Creemers et al. 2016, (cf. (37) in section 4), at least in the present tense.



This structure, with a root /sau/ and “first head” /g/ forming the stem /saug/, is probably only possible as a transitory reanalysis, while the language is developing towards the fully weak structure under (69).

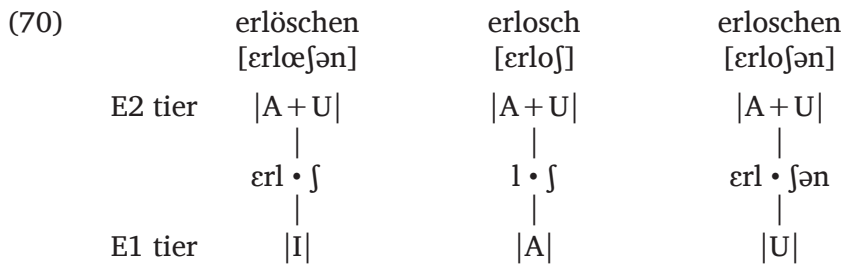
³⁸ Similar effects in the nominal system: *Raum-geräumig* ‘space-spacious’ versus *Luft-luftig* ‘air-airy’, (taken from Klein 2000: 33), where the double |U| in the latter is inhibiting umlaut, but not in the former. The (obviously more powerful) two-tier model may possibly capture this opposition without resorting to parochial diacritics.



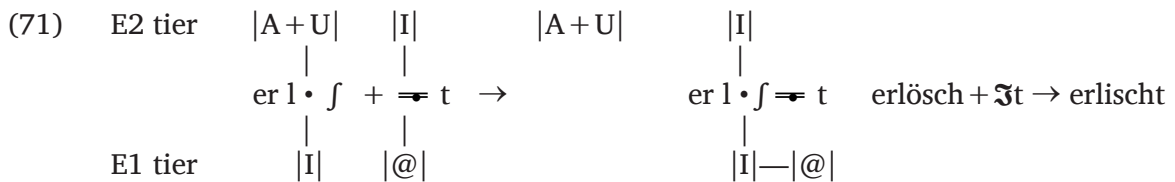
This explains the weak behaviour in the present tense of these verbs.

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 E2 tier: the German verb *erlöschen* ‘to become extinct’. It shows an I-A-U ablaut sequence on the E1 tier and a complex “parasitic element” |A| + |U| on the E2 tier. It suggests that the E2 tier may host a complex object, composed of two elements.



This complex |A + U| on the E2 tier, however, behaves like a single element upon I-umlaut in 23SG present tense, giving rise to *erlischt* ‘it becomes extinct’, as represented under (71).

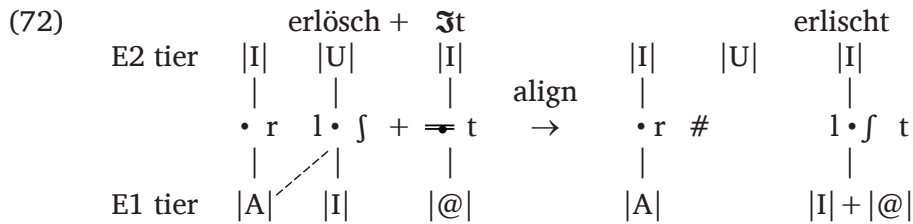


This verb, therefore, violates the calculus permitted in the E2 tier formalism.

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.³⁹ In similar causative pairs, where the base is apophonic and its causative derivative is weak, like *s[I]tzen* → *s[ɛ]tzen* ‘to sit/set’, *l[i:]gen* → *l[e:]gen* ‘to lie/lay’, *tr[I]nken* → *tr[ɛ]nken* ‘to drink/cause to drink’, the causative morpheme is realized by adding |A| to the root.⁴⁰ In the case of *erlöschen* → *löschen*, there is not such a stem opposition: one would rather expect *lūschen* → *löschen*, not *erlöschen* → *löschen*. This makes it probable that the |A| element in the stem *erlöscht*- is only parasitically there: it may be parasitic on the |A| element in the prefix *er*-. If so, the umlauted form *erlischt* falls into place. The full representation is given under (72).

³⁹ I thank Tobias Scheer for drawing my attention to this.

⁴⁰ Cf. Gothic *lithan* ‘go’ and *laidjan* ‘lead’, which adds a left aligned |A|. Causative morphemes are sometimes suffixal (e.g. Eng. *to redder*), sometimes prefixal (e.g. Eng. *to enlarge*).



Observe that the expelled $|U|$ intervenes between prefix and root and prevents the E1 tier from spreading of $|A|$. This intervention is indirect: since an expelled element, i.e. a stray element without association line, is only allowed at the edge of a spellout domain, a boundary $\#$ must be present to license extrametricality of $|U|$. This is the reason why spreading of $|A|$ is impossible after expulsion of $|U|$.⁴¹ 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 this exception to a standard competitive effect on the E2 tier. The configurational blocking of $|A|$ -spreading neatly shows the reality of the expelled $|U|$ element in the underlying representation, despite its lack of exponence in *erlischt*: with stray erasure of $|U|$ or “overwritten” $|U|$, *erläscht* would have been well-formed.⁴²

7 Application to vowel shortening

Thus far we ignored vowel length and vowel shortening in 23SG forms and imperatives. 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 (when the coda ends in a plosive), but verbs with a→e alternation do not. The long vowel $[e:]$ in *geben*, *nehmen*, *treten* shortens to $[i]$ in *gib!*, *nimm!*, *tritt!*, as well as in 23SG present tense, e.g. (*er*) *gibt*, *nimmt*, *tritt*. In *schlagen*, *raten*, etc., however, which have a long root vowel $[a:]$, no such shortening is observed, e.g. *schläft*, *rät*, etc. which have a long vowel, be it tense of lax: $[e:]$ or $[ε:]$.⁴³ The empirical generalization is under (73).

- | | | |
|------|---|---|
| (73) | • Alternating verbs of the a-e class have no shortening | <i>schl[a:]gen – schl[ε:]gt</i> ,
<i>r[a:]ten – r[ε:]t</i> |
| | • Alternating verbs of the e-i class have shortening | <i>g[ε:]ben – g[i]bt</i> ,
<i>tr[ε:]ten – tr[i]tt</i>
<i>vergl[ai]chen-vergl[i]cht</i>
<i>w[ε:]rden-w[i]rd</i> |

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

- (74) • Element expulsion correlates with shortening

Apparently, the competitive tier model with expulsion and addition makes the correct division line. But how to model it?

⁴¹ Further spreading to the prefix to *orlischt* is not possible because of the Edge-In alignment, which is from the prefix inward.

⁴² The only study on the interaction of prefixes and umlaut is to my knowledge Strauss (1982), discussing *beachtlich* ‘notable’ versus *verächtlich* ‘despicable’.

⁴³ See note 10.

In view of the correlation between the short-long dimension and the lax-tense dimension,⁴⁴ we have to decide in what terms we capture shortening. At first glance, the optionality in lax/tense in *schlafen-schläft* without shortening ([a:]-[e:/e:]), suggests shortening in terms of length irrespective of quality. Nevertheless, we cast the shortening conundrum in terms of laxing as it is more in line with existing theorizing on the lax-tense dimension in ET. So we will explore (75).

(75) • Element expulsion correlates with laxing

Consider the traditional vowel charts under (76), which is organized along the tense/lax dimension, taken from Swets (2004: 99).

(76)

	Tense (in open/closed syllables)			Lax (closed syllables)		
High	i	y	u	ɪ	ʏ	ʊ
Mid	e	ø	o	ɛ	œ	ɔ
Low	a			ɑ		
central	ə			–		

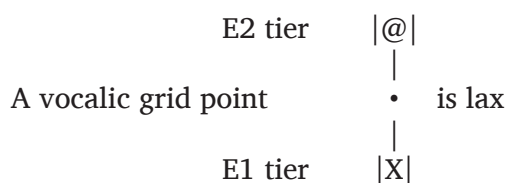
Notice that [ə] patterns with the tense vowels with respect to occurrence in both closed and open syllables in German: *mach[ə]n* and *macht[ə]* are both possible. The same is true for Pomeranian, Frisian, and Dutch. This [ə] is represented by the element |@|. The absence of |@| in the lax vowel system (indicated with the dash) gives room to the hypothesis that lax vowels have |@| as well, albeit in an abstract way: lax vowels come about by {IAU} combined with headed |@| as adopted in Harris (1994), Cobb (1997), Swets (2004), i.e. {IAU} + |@|. In terms of ET, the table becomes as under (77). This additional |@| can be interpreted as a centralizing “manner” in lax vowels.

(77)

	Tense (open + closed syllables)			Lax (closed syllables)		
High	I	IU	U	I—@	IU—@	U—@
Mid	IA	IAU	AU	IA—@	IAU—@	AU—@
Low	A			A—@		
central	@			–		

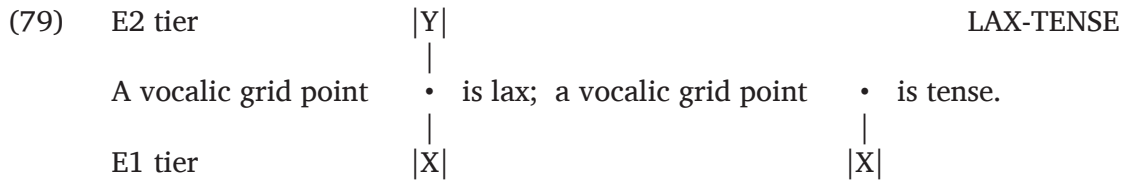
Now, |@| has only existence when it sits alone, being the neutral element under JOIN. So, |@| must sit on a tier where it cannot coalesce with the other elements. We conclude that Harris’s definition of lax vowels must be modeled in CTM as an |@| element on the E2 tier. This gives us (78).

(78) Harris (1994; implemented in CTM)



⁴⁴ Though not in an absolute way, notably in the case of umlaut where [e:] and [ɛ:] are in alternation. Some linguists consider the pronunciation [ɛ:] an artefact, e.g. Grimm’s WDS.

In the absence of this E2 tier element, the vowel is tense. Evidence for an element on an independent tier that causes laxness is the existence of (retracted/advance) tongue root harmony in some languages (Clements 1981, Lowenstamm & Prunet 1988, Backley & Takahashi 1996 (“headedness agreement”). Cast in CTM, tongue root harmony is the spreading of |@| on the E2 tier. Instead of the restriction to |@| on the E2 tier, we explore a generalized version of lax and tense under (79).

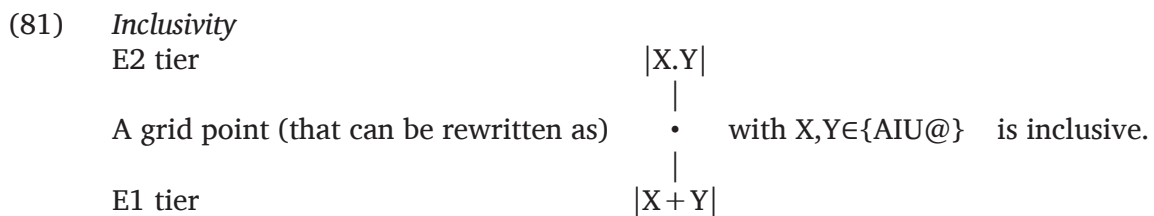


Notice, however, that the very existence of Tier Conflation turns the lax/tense distinction into a dynamic process. If TC occurs, a tense vowel results, if not, the vowel is lax. This gives us the scheme under (80).

- (80) a. A configuration $|X| \text{---} \bullet \text{---} |Y|$ that cannot undergo TC is lax
- b. A configuration $|X| \text{---} \bullet \text{---} |Y|$ that optionally undergoes TC is lax/tense
- c. A configuration $\bullet \text{---} |Y|$ is tense

Let us, therefore, review the circumstances that restrict Tier Conflation. Two conditions on TC hold: 1. TC may not disrupt alignments, and 2. phonological information does not get lost (Containment). The first condition provides the reason why the presence of an expelled element triggers a lax vowel: the expelled element lacks a grid point and cannot undergo TC. Hence, upon TC, the alignment would be disrupted (and hence expulsion would be lifted). This makes that tier conflation is blocked in expulsion contexts. Put differently, in the presence of an expelled element, there must be an adjacent element on the E2 tier, and hence the corresponding vowel is lax. This produces the shortening conundrum in terms of Harris-type laxing.

This approach of the shortening conundrum in terms of the lax-tense dimension cannot be the whole story, however, because lax-tense and short-long are not in a bijective relation. This shows up exclusively in the case of *schlafen-schl[e:]ft/sl[ε:]ft*, a context without element expulsion, with no shortening, even when the vowel is lax. It shows that length must have a definition that is different but not disconnected from the tense-lax dimension. Let us first study the inclusive-exclusive dimension and its relation to length. Consider the definition of (31), repeated under (81).



Inclusive grid points typically cannot undergo TC because of Containment: |X.Y| is fully included in |X + Y| and there would be loss of information upon TC. The absence of TC implies that inclusive gridpoints are always lax: they represent the case under (80) a. Conversely, when a vowel is tense in the sense of (79), it must be exclusive, i.e. it realizes the case under (80)c. But there is a third group: exclusive gridpoints without TC. This is possible, in principle, as long as TC is not obligatory. This disrupts the bijective relation of the lax-tense and short-long dimension. It opens the possibility

that we have the scheme under (82), where a off-diagonal cell is filled: long, lax vowels.

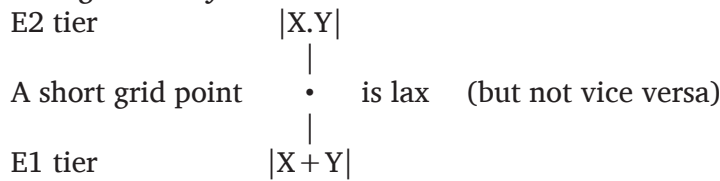
(82) *The non bijective relation of clusivity and tongue root manner (lax-tense)*

sound	[inclusive]	[exclusive]
[lax]	g[ɪ]bt	schl[ɛ:]ft
[tense]	✕	schl[ɛ:]ft

If this reasoning is on the right track, we may identify the formal inclusive-exclusive dimension in CTM with phonological length. For some reason, unclear to us at this moment, the off-diagonal possibility is only available in Standard German in the configuration |I—•—|A|. This symmetry breaking effect cannot be formulated in CTM. This has a principled reason: it cannot be solved in the present model as {IAU} are fully symmetric on the proposed lattice under (24).

Inclusive structures, for instance the Harris-type structure under (78), cannot undergo TC and are, therefore, inherently lax, i.e. they instantiate (80)a. In general, inclusive grid points, which are short because of (81), are lax because of (79). The reverse is not true, exclusive grid points are not tense, because TC is, in principle optional. This brings us to the corollary in (83).

(83) *Laxing corollary*



The inclusive configuration generates the same structures as the Harris-type definition under (78), for all $X \neq Y$ and, furthermore, whenever either $|X|$ or $|Y|$ is $|\@|$. However, the identification under (83) is slightly more tolerant, as it also identifies $|X|—•—|X|$ configurations as lax, for instance the $|I|—•—|I|$ configuration in *gibt* and the $|A|—•—|A|$ configuration in *lassen*. Notice that also $|I|—•—|I + A|$ configurations are identified as lax, with $X = |I|$ and $Y = |I + A|$. On the other hand, all structures without any material on the E2 tier, for instance $•—|A|$ in *schlafen* are identified as tense.

8 Application to alternating verbs in Pomeranian

8.1 Vocalic alternations

Pomeranian (Tressmann 2006; Postma 2018) has virtually lost the $a \rightarrow e$ class of alternating verbs, just as the Low Saxon dialect (Gronings) in the Netherlands did (Reker 1989): there are no *raten-rät* verbs.⁴⁵ The expulsion type $e \rightarrow i$ has survived in 6 verbs: *geewa – hai giwt* ‘to give – he gives’, *gaita – git* ‘(he) pour(s)’, which has the same analysis as in German, where $|A|$ has been pushed out (and the vowel shortened). In addition to this, a new class emerged. Under (84) we give some typical cases of the new alternating verbs.

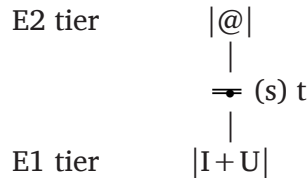
⁴⁵ E.g. *wascha-hai wascht* ‘(he) washe(s)’. I-umlaut is retained in three verbs with open roots, *slåa* ‘to hit’, *gåa* ‘to go’ and *daua* ‘to do’ with $[e^i]$ in 3SG present tense *slåit*, *gåit* and *dåit*, respectively.

(84) Alternating verbs in Pomeranian, taken from Tressmann (2006).

- a. *fal* + **ʒt** [a] → *fült* [y] ‘falls’
forlair + **ʒt** [a:¹] → *forlürt* [y] ‘loses’
- b. *koom* + **ʒt** [ɔ:] → *kümt* [y] ‘comes’
- c. *kruup* + **ʒt** [u:] → *krüpt* [y] ‘creeps’
- d. *drå:g* + **ʒt** [ɔ:] → *drögt* [œ] ‘carries’
- e. *stöit* + **ʒt** [ø:¹] → *stöt* [œ]⁴⁶ ‘bumps’

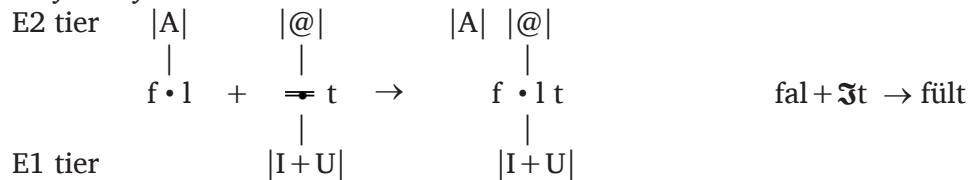
As one can inspect from (84), there is addition of |U+I| to the root, which is sometimes competitive with the stem vowel, as in *fala* ‘fall’, *forlaira* ‘loose’ and *kooma* ‘come’, where |A| is expelled and sometimes coalescent, as in *dråga* ‘carry’ and *stöita* ‘bump’. If we assume the competition effect to be caused by |I| on the E2 tier, as for German, we would not expect expulsion effects with /ai/ and /ei/ diphthongs because of OCP resolution, counter to fact: Pomeranian has *forlaira-forlürt* ‘lose(s)’. So let us assume the |@| to be on the E2 tier and the element |I| on the E1 tier. In addition there is an |U| element in the ending. As the E2 tier can only host one element, we must assume that |U| is on the E1 tier, like in (85), to be compared with (47).

(85) 23SG verbal suffix **ʒ** (s)t in Pomeranian



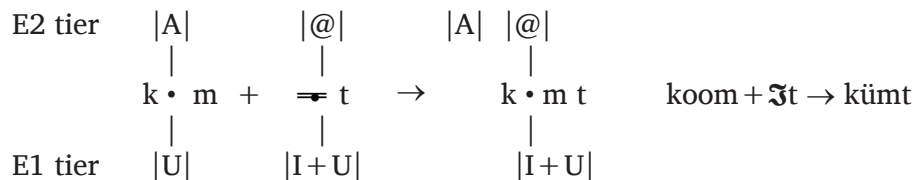
Let us start with the typical Pomeranian case, where the verbal root is on the E2 tier, cf. (4), e.g. *fala-fült* ‘fall’ and *forlaira-forlürt* ‘loose(s)’. *Fala* is analyzed under (86).

(86) *fala* – *fült* ‘fall’



As we see, the suffixal |@|-element pushes out the radical |A|, which is on the E2 tier. Together with the U element on the E1 tier, the root vowel becomes [y]. A variant of this case is *kooma* ‘come’ which has a complex vowel. It is given under (87).

(87) *kooma* – *kümt* ‘come’



The other cases under (84) are completely straightforward. We give them under (88)–(90) for reference only.

⁴⁶ Pomeranian short complex vowels are usually accompanied with a pre-articulation, e.g. the short rounded low mid vowel [œ] as [ʷœ] and the short high rounded vowel [y] as [ʷy], realized on one timeslot. Also post-articulated realizations can be heard. For details, cf. Postma (2018a).

- (88) *kruupa – kriipt* ‘creep’
 E2 tier |U| |@| |U| |@|
 | | | |
 kr • p + t → kr • pt kruup + $\mathfrak{I}t$ → kriipt
 | |
 E1 tier |I+U| |I+U|
- (89) *dråga – drögt* ‘dry’, *låta – löt* ‘let’, *fåta – föt* ‘fetch’
 E2 tier |U| |@| |U| |@|
 | | | |
 dr • g + t → dr • g t dråg + $\mathfrak{I}t$ → drögt
 | |
 E1 tier |A| |I+U| |A+I+U|
- (90) *stöita – stöt* ‘bump’
 E2 tier |U| |@| |U| |@|
 | | | |
 st • t + t → st • t t stöit + $\mathfrak{I}t$ → stöt
 | |
 E1 tier |A+I| |I+U| |A+I+U|

All these cases neatly show the coalescence of elements on the E1 tier and the competition of elements on the E2 tier. Notice that, in addition to expulsion of an element, there is vowel shortening whenever an element is expelled. This shortening follows the generalization made for German. As Pomeranian always has expulsion, be it either |A| or |U|, 23SG present tense forms always shorten and realize as lax vowels.⁴⁷

8.2 Verbs with spirantization in 23SG present tense

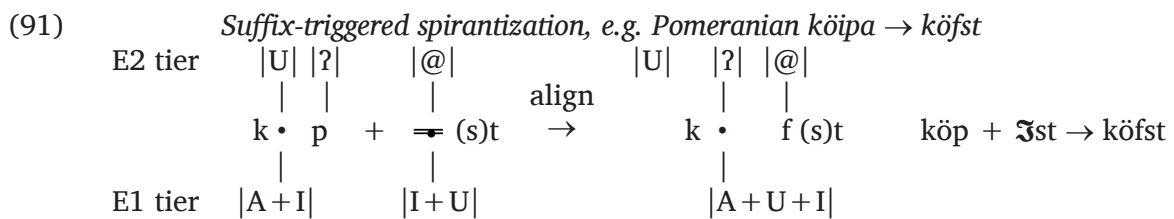
West Germanic has a class of weak verbs that – despite their weakness – show a special kind of alternation in 23SG present tense, i.e. violating the generalization that only strong verbs show root alternation. The alternation is not vocalic but consonantal: these verbs display consonant change upon 23SG suffixation, i.e. where a coda obstruent {bpgkdt} that is part of the root, realizes as {fxs} in the context of –(s)t.⁴⁸ We provide an analysis for Pomeranian because Standard German has lost this class (not accidentally as we will see). Most dialects of Coastal Germanic have retained at least some of them and have even extended them, e.g. *köipa-köft* ‘buy(s)’ in Pomeranian, Isle Frisian *kaipe – hi kaft*, ‘buy(s)’ and *libje-leveste* ‘live(s)’,⁴⁹ Low Saxon dialects *ko:pen-he köft* ‘buy(s)’. It is visible in only one verb in standard Dutch (e.g. *hebben-heeft* ‘have/has’), but in many Dutch dialects there is loss of manner in /g/ in *zeggen – hij zeyt* ‘say(s)’, *leggen – hij leyt* ‘lay(s)’. In Old Germanic, it happened with 4 verbs that have a geminate consonant in the coda: e.g. OE *hæbbe* ‘I have’, *libbe* ‘I live’, *secge* ‘I say’, and *hycge* ‘I think’, which had *hæfst/hafast*, *leofast/lifast*, *sægst/*

⁴⁷ The Pomeranian verbs that have the German-type umlaut factor (i.e. without |U|) in (47) are: *eeta-it* ‘eat(s)’, *gaita-git* ‘pour(s)’, *geewa-giwt* ‘give(s)’, *haita-hit* ‘be/is called’, *neema* ‘to take’, and *leiga* ‘to lie down’. All other verbs have the Pomeranian umlaut factor (85). There are two ways to go: we simply consider these six verbs irregular, or we find an new analysis of the additional |U| part in the Pomeranian umlaut factor: e.g. it might be prefixal in origin, as the verbal ge-prefix lost exponence in Pomeranian verbs.

⁴⁸ It happens in a subset of the verbs that have spirantization in past tense formation as in German *denken-dacht* ‘to think-thought’, Flemish *werken-wrocht* ‘to work –wrought’, etc.

⁴⁹ For instance the dialect of Schiermonnikoog (GRTP, location B004p).

seġ(e)st, and *hyġst/hogast* as their 23SG present tense forms. The origin of the geminate lays in the older present tense suffix *-jan*, of which the place element |I| in the consonant /j/ was floating, i.e. a consonantal gridpoint was deactivated (cf. section 5.6). This caused I-umlaut of the present tense stem (rückumlaut) in addition to gemination of the coda consonant. So, historically, the process was not frication (of /b/ → /f/) but obstruent formation (from /f/ → /b/) or gemination in the non-23SG forms. Synchronically, however, the processes is spirantization, to be analyzed entirely parallel to our reversed analysis of historical A-umlaut, i.e. it realizes synchronically as I-umlaut + expulsion. In Element Theory, spirantization must be described as expulsion of |ʔ|, the element that represents stopness. For Pomeranian *köipa-köft*, we tentatively propose an analysis along the lines of (91). Notice that the consonant /p/ retains its manner features and place feature |U| on its own C-tier (not drawn) during the derivation while its |ʔ| is expelled, resulting in /f/. The reason that the configuration has |ʔ| on the E2 tier must find its origin in the gemination process, and might be historically parallel to |N| and |U| of section 5.6 and 5.7. In synchrony, it is a single |ʔ|, and is pushed away under alignment.



Notice that the tense vowel [ø:i] becomes lax [œ] under acquiring an element on the E2 tier. The mechanism may become clear by recalling the shortening conundrum in section 7: whenever there is irreducible material on the E2 tier, the grid point is interpreted as lax, in compliance with (79). The absence of this class in modern German 23SG morphology leads us to the assumption that |I| as part of the German umlaut factor is incapable of expulsion of manner elements like |ʔ|, while |@| in Pomeranian and Low Saxon do interact with this manner feature. We tentatively suggest that |@| being the null element in the place lattice is also the null element of the manner lattice. If so, the particular activity of |@| in the manner space becomes understandable.

(92) The |@| element of the place lattice is one and the same as |@| of the manner lattice.

We leave the interaction between place elements and manner elements for further study.

9 The dialectology of the umlaut factor

Let us now return to the dialectology of the realization of the epenthetic vowel. As we have seen, the West-Germanic variants with umlaut in 23SG are assumed to have an analysis parallel to German, modulo the lexical differences in vocabulary items and suffixes. However, High German and Low German have epenthesis while Pomeranian, Limburgian, and Low Saxon do not. Instead of taking it an arbitrary spellout rule, we tie it to differences in the 23SG morpheme. The different location of the floating |I| and |@|: |I| is on the E2 tier in German while it sits on the E1 tier in Pomeranian. This different localization can be deduced from the presence of OCP effects without shortening in German *leiden* ‘suffer’, and the lack of the OCP effects visible in Pomeranian shortening in r[i:]ra – r[ɪ]t ‘he ride(s)’ and expulsion of |A| in Pomeranian *forlaira-forlirt* ‘(he) loose(s)’.

(93) Representation of 23SG present tense

	German	Pomeranian	Low Saxon
	-stress	-stress	-stress
E2 tier	I	\@	\@
	≡(s)t	≡(s)t	≡s/t
E1 tier	\@	I+U	I
	exclusive	inclusive	inclusive

In addition to this, Pomeranian (and most Limburgian dialects in the Netherlands) have an additional |U| element on the E1 tier. We added Low Saxon in (93), which shares the absence of |U| in 23SG with German,⁵⁰ but shows a general vowel shortening with i:i verbs. This suggests a reverse tier distribution of the |I| and |\@| within the umlaut factor in Pomeranian, Limburgian and Low Saxon. The different location of |\@| in Pomeranian, Limburgian and Low Saxon makes the suffix inclusive in Pomeranian/Limburgian/Low Saxon but exclusive in German. Inclusive structures only come about in German when the umlaut factor aligns in stems with |I| on the E1 tier (e.g. in *geben*) and only in these cases German shows shortening. In all other cases, there is exclusivity (e.g. |I|—•—|A| in *schläft*) and a long vowel shows up. We therefore have the fourfold empirical correlation under (94)2–5 that correlates with the theoretical concept of clusivity.

(94)	German	Pom.	Low Saxon
1. Clusivity of vocalic grid point in 23SG	exclusive	inclusive	inclusive
2. OCP resolution in 23SG when I in root (<i>bieten</i> -class without shortening)	yes	no	no
3. Shortening in 23SG upon alternation	e-i class only	always	always
4. ə-realization in d/t—(s)t contexts	+	–	–
5. Occasional expulsion of ʔ in 23SG	–	+	+

Interestingly, as we saw before, exclusivity of an active grid point is tied to a “length” realization, e.g. |A|—•—|I| and realized as long and tense [e:] in *geben*, while inclusivity, e.g. |I|—•—|I| is realized as short and lax [i] in *gibt*. It is attractive to tie the epenthetic behaviour to a similar length contrast upon in situ spellout of a deactivated grid point in the 23SG morpheme. This predicts length effects upon spellout in German, but not in Pomeranian and Low Saxon. We therefore hypothesize a “lax” spellout rule given under (95) and a “tense” spellout rule of (96).

(95) Underlying structure of Epenthesis (Pomeranian, Limburgian, Low Saxon)

	-stress	
E2 tier	\@	
An inclusive deactivated grid point	t ≡ t	is spelled out “short”: [t(t)]
E1 tier	X	

⁵⁰ North and Central Limburgian have the same umlaut factor as Pomeranian, i.e. with an additional |U| element. South Limburgian and Belgian Limburgian miss this extra |U| element.

(96) *Underlying structure of Epenthesis (High German, Low German)*

	-stress	-stress	
E2 tier	X		
		TC	
An exclusive deactivated grid point	t ⇐ t	→	t ⇐ t is spelled out “long”: [tət]
E1 tier	@	@.X	= @

The drawn structures concern 3SG present tense contexts. A parallel rule (*mutatis mutandis*) holds for 2SG contexts. Dutch and Frisian (and perhaps Yiddish) are underlyingly different from these umlaut varieties because they do not have an umlaut factor as part of the 23SG morpheme, i.e. they do not have an deactivated grid point and do not need these spellout rules.

10 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 survive 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 must be 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 10.1. And there is Trommer’s (2010) derivational approach, which is evaluated in section 10.2.

10.1 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. (97)abc.

(97)	a.	<i>spalt</i> + <i>t</i> → <i>spal</i> tt = <i>spalt</i>	hence epenthesis is needed: <i>spaltet</i>	ok
	b.	<i>rat</i> + <i>t</i> → rät = rät ≠ <i>rat</i>	hence no epenthesis is needed	ok
	c.	<i>tret</i> + <i>t</i> → <i>trit</i> + <i>t</i> = <i>tritt</i> ≠ <i>tret</i>	hence no epenthesis is needed	ok
	d.	<i>spalt</i> + <i>st</i> → <i>spalt</i> st ≠ <i>spalt</i>	no epenthesis is needed	wrong!

It does not give the correct predictions for epenthetic schwa with 2SG forms, cf. (97)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 on the surface forms in dental final roots either: *er hält*→ *du *hälst/hältst*, 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 the word design model. What is more

worrying is that the rules of word design are rather stipulative and hardly explanatory.⁵¹ 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. *schafen* > *schlaf(e)!* and 3. *binden-binde!/*bind!*, i.e. the imperative conundrum discussed in the sections 2.1 and 5.2. This suggests that this model of surface constraints quickly meets its boundaries.

10.2 Trommer's derivational approach

Trommer's OT approach assumes that the interaction of umlaut and schwa-epenthesis in German 2SG/3SG verb forms is governed by synchronic grammar (Trommer 2007, 2010, Trommer & Zimmerman 2014). In contrast to Neef, it is derivational with respect to the grammar as a whole: lexeme selection + concatenation + phonological calculus. As empirical input, Trommer uses the following data from German diminutive formation. Trommer then compares stem alternations in diminutive and stem alternations in present tense. Consider the diminutive pattern first.

(98)	a.	Hund – Hündchen	umlaut (ʒ)	'(little) dog'
	b.	Monat – ø	(no output)	'(little) month'
	c.	Bude – Büdchen	ʒ + drop of schwa	'(little) hut'
	d.	Haken – Häkchen	ʒ + drop of -en-	'(little) hook'
	e.	Vogel – Vögelchen	ʒ + transparency of -el-	'(little) bird'
	f.	Bruder – Brüderchen	ʒ + transparency of -er-	'(little) brother'

The umlaut 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 (98)bc, the intervening syllable with schwa is dropped, but in the case of intervening -el/-er/(-em),⁵² *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 and epenthetic schwa mutually exclude each other. Just like the schwa in *Büd(e)chen* in (98)c, epenthetic schwa in *rät(e)t* cannot be realized. Trommer's approach is identical to the locality approach of the licensing of the floating umlaut factor of Hermans & Van Oostendorp (2008), henceforth H&vO. In the latter analysis, H&vO assume an umlaut factor (ʒ in our notation), which is part of the diminutive morpheme. This ʒ adds a coronal feature to a vocalic target. Some structural requirements are assumed:

1. The target must be stressed.
2. Targeting a vowel proceeds under spreading.
3. Spreading may not skip potential targets.

⁵¹ Changing the root vowel (or even the root in general) in order to "let forms be different" is a rather powerful mechanism. No constraint or mechanisms is given. This is close to "everything goes". The German strong verb system is much more restricted, even in the domain of "irregular" verbs.

⁵² This sequence does not occur in German but in Limburgian *bodem-bödemke* '(small) bottom'.

These three requirements are also part of the analysis in terms of our CTM Model. In addition to this, H&vO impose another relevant constraint: BINSPAN, which blocks any dominance that exceeds binary branching. This penalizes a form like *Mönätchen* on a par with *Mönatchen* which all violate BinSpan: e.g. /Mönät-ʃchen/, where the “three-span” is underlined. In order to capture the deletion processes *Bude + chen* => *Büdchen*, *Monat + chen* => **Möntchen*, both H&vO and Trommer use three constraints: MAX V and MAX @, which impose to maximalize morphemes with full vowels and schwa, respectively, and *∅ (a ban on complete non spellout). Full vowels may not be dropped as easily as stand-alone schwa, while a complete non spellout, ∅, i.e. the null parse, is ranked between these two. One more structural constraint is needed: (stress) licensing of the floating umlaut, which our model also adopts. We give the two parallel optimality tableaux in (99)–(100).

(99)

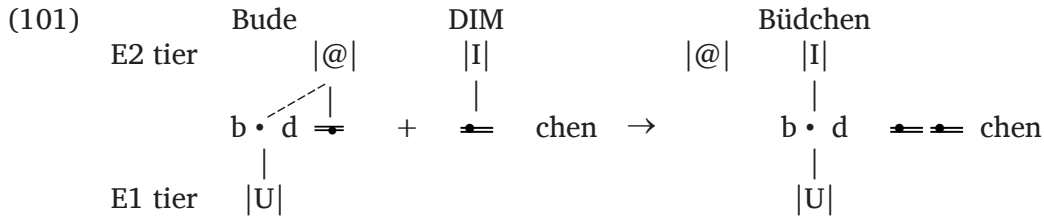
		MAX V	LIC-COR	BINSPAN	*∅	MAX @
	a. bud-e-ʃchen		*			
	b. <u>büd</u> -e-ʃchen			*		
	c. ∅				*	
☞	d. <u>büd</u> -ʃchen					*

(100)

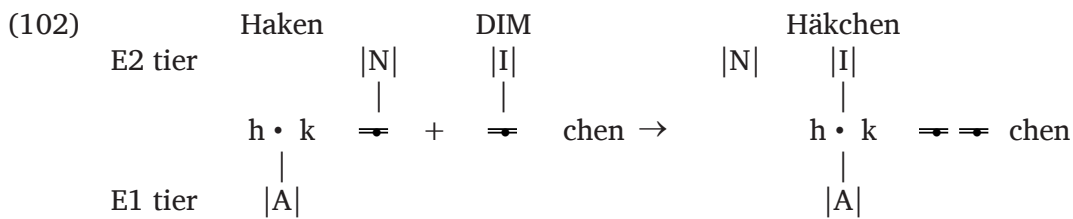
		MAX V	LIC-COR	BINSPAN	*∅	MAX @
	a. rat-e-tʃ		*			
	b. <u>rät</u> -e-tʃ			*		
	c. ∅				*	
☞	d. <u>rät</u> -tʃ					*

We do not fully evaluate the OT analysis; we only want to mention three problematic points. First, as ʃ is phonological, we must exclude phonological drop of ʃ. So, a constraint MAX ʃ, ranked between *∅ and Max @, should be added along with two extra candidates /budchen/ and /budechen/. Moreover, we must penalize floating ʃ, otherwise BINSPAN can be met vacuously. One cannot exclude floating ʃ by assuming a constraint NOFLOATINGʃ with a high ranking, unless it makes reference to the morphology, because floating is to be defined in terms of its morphological anchoring point. This turns the explanation into an interface account. We think that these problems are insurmountable as long as no reference is made to the morphology.

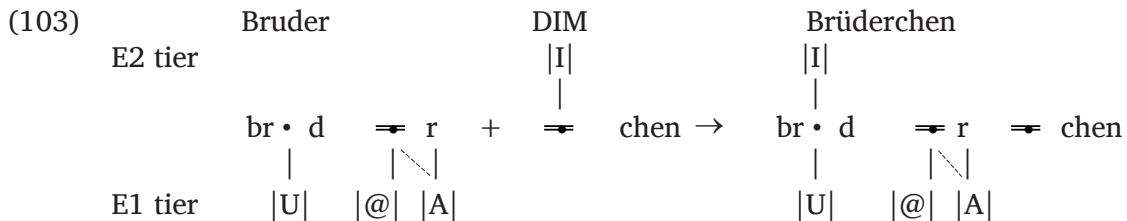
The competitive tier model has various theoretical assumptions in common with Trommer’s approach although they differ in implementation. While Trommer opts for an OT implementation, our competitive tier model is a principle-based account. Despite the problems with BINSPAN, the empirical parallel that Trommer (2010) notices between epenthetic schwa (incompatible with umlaut in 23SG), and the class marker schwa (incompatible with umlaut in diminutives), is too interesting not to consider seriously. Let us then study how the competitive tier model might handle this parallel. In (101) we apply the nominal umlaut factor that we introduced in (4) for Pomeranian: a floating |I| element on the competitive E2 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].



Let us assume that /n, r, l, m/ participate in the consonantal tier, and that only syllabic /n/, |N|, being without any place features, stands on a deactivated grid point on the E2 tier, just like the place-depleted schwa. (It is the schwa of the nasal space, while /r, l, m/ are consonants with place features |A| and |U|). We then get the opposition in (102)–(103). In these configurations, [ən] patterns with [ə], being both expelled by the umlaut factor.



The suffixes [əl], [ər], and [əm], on the other hand, are unaffected as they are in situ licensed by spreading the place features present in /r/, /l/ and /m/. This is the same mechanism as assumed in Trommer’s analysis, implemented in CTM.



Notice that the hypothesis that German syllabic or moraic /n/ have |N| on its E2 tier has immediate consequences for its behaviour of those syllabic n-segments that is part of the verbal stem, e.g. *denken*, discussed in section 5.6, which might be expelled on past tense formation (ablaut). This illustrates that the model presented here is extendible to the nominal umlaut cases discussed in Trommer (2010). The empirical coverage of the competitive tier model is potentially broader than Trommer’s model, which was designed just to handle I-umlaut and cannot be extended to the e→i alternations in an obvious way.

11 Summary, conclusions, speculations, and problems

Competition of segmental material is inherent in all phonological proposals of template satisfaction. Segments are aligned with a prosodic template and compete for prosodic space. In this paper we have argued that vocalic template satisfaction displays 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 (E1 tier) where the addition of an element causes merger, and a competitive tier (E2 tier), where addition of an element competes with eventual elements and may expel another element from the prosodic template. A detailed modeling of this hypothesis allowed us to solve the epenthesis conundrum, which

describes the empirical generalization 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 form, sometimes from the non-23 form. Finally, we outlined an explanation of the shortening conundrum. We modelled the universal principles under (104), of which only nr. 2 is new, and the arbitrary assignments by the Lexicon under (105):

(104) Universal Principles

1. Template satisfaction in the Phonology, not in the Lexicon
2. Apart from the C-tier, two vocalic tiers; E1 tier is coalescent; E2 tier is competitive
3. Alignment (i.e. competition of segments/elements)
4. Edge-In (Alignment from the affix inward)
5. Phase Theory
6. Lax-Tense and Length Rules
7. Obligatory Contour Principle (OCP)

The second principle, the Competitive Tier, is what is defended in this paper. The other principles were formally implemented with it, forming one overall model that allowed a formal calculus of phonological principles. Furthermore, we had some lexical assignments.

(105) Language-dependent Assignments for High German

E1 tier	E2 tier
(vowels of...)	(vowels of...)
<ul style="list-style-type: none"> • weak verbal stems • strong verbal stems 	<ul style="list-style-type: none"> • parasitic element A in strong verbs (A-umlaut) • parasitic element I in half-strong verbs (Rückumlaut) • floating @ , imperative morpheme (for all verbs)
<ul style="list-style-type: none"> • @ part of 23SG • @ part in 2PL 	<ul style="list-style-type: none"> • I part of 23SG (for all verbs)

The foundation of these lexical assignments is not entirely clear: what rules the assignment of segments to a specific tier? Is it Saussurian arbitrariness of the lexicon? A connection with morpheme status might be at stake, at least historically. Suffixes seem to realize their vocalic material on the E2 tier and retain this assignment even after reanalysis as part of the root. The competitive nature of suffixes and the competitive nature of the E2 tier might, therefore, be related.⁵³

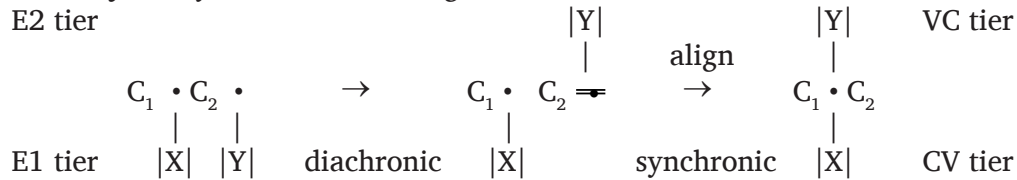
Let us briefly speculate on the origin of the suffix connection. Our speculation is mainly diachronic in nature, but fully compatible with the synchronic interpretation of the E2 tier in terms of the tense-lax distinction. We tentatively relate the E2 tier to lateral CVCV phonology (Lowenstamm 1996; Scheer 2004). Suppose that the E1 tier and the E2 tier differ with respect to the alignment to the consonant within its (CV) unit. While the vowel in an unordered (CV) unit is standardly aligned after its C giving rise to /CV/, vocalic elements on the E2 tier have a reverse alignment, i.e. they have their orientation with respect to the subsequent consonant, E1 tier: /CV/; and E2 tier: /VC/.

⁵³ For an interesting Berber case of *morpheme* competition by phonological template satisfaction, cf. Lahrouchi (2013).

(106) The E1 tier is CV aligned; the E2 tier is VC aligned

In this view, the E2 tier is the source of closed syllables and the emergence of lax vowels, which we identified as a vocalic *manner* realized on the E2 tier. We represent this realignment by a formal feeding mechanism of the E2 tier in diachrony under (107).

(107) *Closed syllable formation and laxing*



First we have a (CV)(CV) pattern with X and Y representing their vocalic element content on the E1 tier, say Gothic *badi* ‘bed’. When, as part of a diachronic change, its grid point is deactivated under simultaneous flipping of the vowel to the other tier, it receives pre-consonantal realization under synchronic alignment. This double change might be caused by the fact that there is a universal preference for CV alignment to be taken “Edge-In” in the sense of Yip (1988) which is, in the case of a suffix and right-to-left alignment, a VC order, producing modern English *bed*. The typical expulsion effect shows up whenever this process happens twice (or – in synchrony – a floating feature).

What makes this interpretation especially attractive, is the link it lays between the E2 nature of an element and its suffixal origin (Edge-In from the suffix). In the mean time, these considerations do not shed light on the competitive character of the E2 tier. The competitive nature of the E2 tier seems independent, but it might be related to the affixal origin of E2-material as well, as affixes often compete for prosodic space. Nothing hinges on this preliminary interpretation of CTM as reversely aligned (CV) units, but the phonological calculus presented in this paper and most empirical details are compatible with it.

Let us finally discuss a problem of the model. It does not concern the competitive tier model itself, but its implementation with the Hasse diagram in (24). This diagram predicts a symmetric behaviour of the three basic elements IAU. However, there are various empirical symmetry breaking effects, especially with respect to sonority. In the first place, expulsion of |A| is the most common, expulsion of |U| is somewhat rarer, while the expulsion of |I| is not attested. This comes as a surprise in view of the symmetry in the model and cannot be captured by it. Secondly, the Harris-type configuration |@|—•—|X| is always lax as predicted (because of inclusivity), with the exception of when |X| = |A|, for instance in the aligned imperative *schlaf!*, which has |@|—•—|A| but realizes as tense [a:]. This does not happen with |I| and |U|. Finally, the lax-tense alternation only occurs with unlauded |A| (*schl[e:]ft/schl[ɛ:]ft*) not with (vacuously) unlauded |I| (*b[i:]gt/*b[r:]gt*) nor with unlauded |U| (*g[y:]ter/*g[ɣ:]ter* ‘goods’). This problem shows that the IAU-symmetric model has defects, or rather, it does not cover the empirical facts with respect to symmetry breaking by sonority. These problems are, however, not inherent to the theoretical assumption of the Competitive Tier itself, only of the CTM model presented with a sonority symmetric element lattice. Other lattices are worthwhile being explored, for instance the interchange of |A| and |@| in the lattice in (24)a. Various researchers have recently suggested that |A| is not an element like the others, but an underspecified one (Cavirani & Van Oostendorp 2017; Faust 2017) or even pure prosodic space (Pöchtrager 2018).

Competing Interests

The author is member of the editorial board of *Glossa*.

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