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A foot-based approach to interactions of tonal accent and consonantal strength

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1. Introduction

It is a well-established phonological generalization that foot-medial onsets tend to undergo lenition (e.g., Honeybone 2012, Katz 2016); a well-known example is flapping in English, where /t/ and /d/ are flapped in the onset of certain unstressed syllables (e.g., *write* vs. *writer*) that corresponds to a foot-medial position (Davis and Cho 2003). Similarly, it is commonly assumed that such lenition processes are always ‘top-down’ but never ‘bottom-up’ (e.g., Blumenfeld 2006; Rasin 2016). Along these lines, certain prosodic positions (such as foot-medial onsets) can influence the realization of segments (= top-down) but weak, lenis segments are not expected to influence foot structure (= bottom-up). In this paper we argue that such bottom-up interactions are in fact possible and attested, even if they may occur less frequently than top-down lenition processes. Specifically, we propose that word-medial consonant quality can affect foot structure. Our main empirical evidence comes from West Germanic (Franconian) tone-accent systems that contrast Accent 1 and Accent 2; such varieties are spoken in parts of Belgium, Germany and the Netherlands. Two minimal pairs from Mayen (Schmidt 1986) are given in (1). As these examples show, the accents can form lexical minimal pairs (1a) as well as morphologically alternating forms (1b).

- (1) Two tone accent minimal pairs from Mayen Franconian
- | | | |
|----|----------------------------------|----------------------------------|
| a. | [man ¹] ‘basket’ | [man ²] ‘man’ |
| b. | [ʃta:n ¹] ‘stone-pl’ | [ʃta:n ²] ‘stone-sg’ |

In certain dialects, the voicing quality of post-tonic onset consonants correlates with accent assignment. For our purposes, we will refer to voiced consonants as ‘lenis’ and to voiceless consonants as ‘fortis’; this follows established tradition in Germanic Linguistics and corresponds to notions of consonantal strength (Iverson and Salmons 1995). From a

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diachronic perspective, the dialect area of particular interest to us has traditionally been referred to as so-called ‘Rule A’ (see Schmidt 1986 for discussion). In Rule A, items with originally lenis intervocalic consonants will always receive Accent 1—this generalization is diachronically exceptionless. Items with originally fortis intervocalic consonants, on the other hand, will typically receive Accent 2—this second generalization holds for most, though not for all contexts (see §2 for further discussion). Over the past few centuries, however, widespread consonant lenition of originally fortis obstruents in German has made these once predictable interactions opaque in many Rule-A dialects; still, certain dialect areas have not undergone consonant lenition, thus generally preserving the original situation until at least the 20th century. For purposes of exposition, we use Aegidienberg (Müller 1900) and Cologne (e.g., Münch 1904) as examples of such dialects. As already observed by both Müller (1900:§3) and Münch (1904:§21), disyllabic words with word-medial lenis consonants (lenis obstruents, sonorants) always have Accent 1 (we discuss a few apparent, mostly morphologically conditioned exceptions in §2); words with word-medial fortis consonants typically have Accent 2 (but may sometimes have Accent 1). Two near-minimal pairs are provided in (2), where items with intervocalic lenis consonants receive Accent 1, and items with intervocalic fortis consonants receive Accent 2:

- (2) Interactions of voicing and tonal accent (examples from Aegidienberg, Müller 1900: 4)
- a. [i:¹.zən] ‘iron’ ~ [ri:².sən] ‘tear’
 - b. [fu:¹.vən] ‘push’ ~ [fu:².fəl] ‘shovel’

In what follows, we propose a first-time synchronic, foot-based analysis of these predictable interactions between tonal accent and word-medial consonant strength in Franconian dialects. As we show, our approach is comparable to the foot-based analysis of ternary quantity in Estonian and its interaction with consonant gradation (based on Prince 1980, Odden 1997). Furthermore, we argue that the generalizations on Franconian are hard to express with an approach based on lexical tones. In doing so, we aim to contribute to two central, ongoing debates in prosodic typology: 1. the interaction of voicing and metrical structure, and 2. the phonological representation of tonal accent.

The ‘traditional’ analysis of tonal accent derives tonal accent from a lexical tonal opposition that interacts with stress and intonation (see Gussenhoven 2004 for an overview of tonal analyses of several tone-accent systems, including Franconian). More recently, an alternative ‘metrical approach’ has been developed, where tonal differences between the accents in at least some tone-accent systems are attributed to two different types of feet, which then leads to different mappings of intonational tones (see, e.g., Iosad 2016a for dialects of Danish; Hermans 2012, Köhnlein 2016, Kehrein 2017, Van Oostendorp 2017 for Franconian; Iosad 2015, Morrison 2019 for Scottish Gaelic; Morén-Duolljá 2013, Iosad 2016b for North Germanic). Proponents of the metrical approach typically argue that there is independent evidence in favor of such foot-based analyses, which is also at the core of our analysis.

This paper is structured as follows. In §2, we provide some more background on Franconian tonal accent and discuss relevant in more detail. §3 gives a foot-based analysis of the Franconian facts, formalized in Optimality Theory (Prince and Smolensky 1993). In §4, we show that Estonian displays morpho-phonological interactions that are comparable to the Franconian situation. In §5, we provide a few conceptual arguments indicating why

we believe that a foot-based approach is more well-suited to capture the patterns in question than competing analyses with lexical tone. §6 concludes the paper.

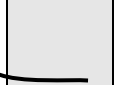
2. Franconian data

In this section we provide a background to West Germanic (Franconian) tonal accent by briefly describing its genesis, distribution, and realization across dialects (§2.1). In §2.2 we then provide data from two Rule A dialects for our analysis.

2.1 Background and tonal accent

Franconian is a coverall term in the English-language literature for a group of West Germanic dialects spoken in western Germany, Belgium, and the southern Netherlands. In a subset of these varieties, two lexically-contrastive tonal accents are proposed to have emerged after the syncope of post-stress vowels. The accents are typically restricted to heavy syllables with two sonorant moras. These tonal accents are typically referred to as Accent 1 and Accent 2. The realization of these accents differs among two primary groups, traditionally called Rule A and Rule B. Our generalizations are drawn from two grammars of Rule A dialects; Aegidienberg (Müller 1900) and Cologne (Münch 1904). In phrase-medial position in Rule A dialects, disyllabic words using declarative intonation are typically realized with a falling tone in the first syllable for Accent 1, while Accent 2 is realized with a high, level tone in the first syllable. Similarly, Accent 1 in interrogatives is realized as an early rise, and Accent 2 is realized as a late rise. Idealized tonal contours for the tonal accents in the Cologne dialect are provided in Figure 1 (taken from Peters 2006).

Figure 1. Tonal contours in Cologne, focus, non-final position; stressed accent syllable non-shaded, overall post-tonic contour shaded.

Context	Accent 1		Accent 2	
Declarative, non-final position				
Interrogative, non-final position				

2.2 Interactions of segmental structure and tonal accent

Two generalizations emerge regarding disyllabic words in Rule A dialects: (1) disyllabic words with medial lenis consonants always receive Accent 1; (2) disyllabic words with medial fortis consonants typically receive Accent 2 but may also receive Accent 1. These generalizations are explicitly stated by both Müller (1900: §3) and Münch (1904, §20, 21). Furthermore, word-medial sonorants behave like lenis obstruents, therefore receiving Accent 1. Examples are provided in (3); all examples are adapted to IPA.

(3) Segment-tone interactions for Cologne and Aegidienberg

- a. Cologne (Münch, 1904)
- | | |
|------------------------------------|-----------------------------------|
| [o: ¹ ʏə] ‘eye’ | [lo: ² fə] ‘to run’ |
| [fre: ¹ zə] ‘to freeze’ | [ri: ² sə] ‘to tear’ |
| [drø: ¹ mə] ‘to dream’ | [ʃli: ² sə] ‘to split’ |
- b. Aegidienberg (Müller, 1900)
- | | |
|----------------------------------|-----------------------------------|
| [i: ¹ zən] ‘iron’ | [ʃu: ² fəl] ‘shovel’ |
| [ja: ¹ ʏən] ‘to hunt’ | [ri: ² sən] ‘to tear’ |
| [ly: ¹ nən] ‘to pay’ | [la: ² xən] ‘to laugh’ |

As discussed by these authors, these predictable interactions reflect the diachronic distribution of tonal accent, where originally word-medial lenis consonants always lead to Accent 1. Synchronic exceptions to these generalizations exist; they are typically restricted to words which are expected to receive Accent 2, but instead receive Accent 1. Historically, these exceptions stem from the fact that vowel height in originally long (i.e., non-lengthened) non-high vowels received Accent 1 independent of consonant voicing. For example, the form [ʃlo:¹fə] ‘to sleep’ surfaces with Accent 1 in the Cologne dialect because it derives from Middle High German MHG *slāfen* with the long low vowel /a:/. “Due to other other changes in the systems (such as vowel lengthening), the vowel-height correlation is synchronically opaque. These historically predictable exceptions are addressed in §3.1 of our analysis.

In addition, some more exceptions have arisen over the centuries where we find Accent 2 instead of the expected Accent 1. Such exceptions, however, seem to be largely morphologically conditioned and might therefore not constitute exceptions to ‘automatic’ phonology. For Aegidienberg, Müller (1900: 12) mentions that comparative forms of adjectives receive Accent 2 despite a word-medial voiced consonant, an example being [ʃy:²nər] ‘more beautiful’. For Cologne, Münch (1904) also transcribes certain apparent monomorphemic exceptions; at least in part, however, these appear to be mistranscriptions. Some examples are, [hœənər] ‘horns’, which should receive Accent 1 according to Münch’s generalizations because of the intervocalic nasal but is once transcribed with Accent 2 (p. 36) and once with Accent 1 (p. 19); the word [bro:dər] ‘brother’ is once transcribed with Accent 2 (p. 143) and three times with Accent 1 (p. 55, twice on p. 187). A few words, such as [ʃni:dər] ‘snider’, are transcribed only with Accent 2 (p. 42, 53, 90) and thus look more like ‘true’ exceptions. They are, however, limited in number, which is why we do not regard them as problematic for our approach—note also that Münch’s incomplete index contains no less than 1200 items.

3. Franconian analysis

In this section we provide a formal account of the interactions between segments and tonal accent discussed in §2.2. We begin by showing in §3.1 how segmental strength influences footing in the dialects under investigation. In a second step, we show how our foot-based analysis extends to the main surface correlates of the tone-accent contrast, viz. (obviously) tone (§3.2) and duration (§3.3).

3.1 Segmental strength and foot structure

Regarding interactions of consonant strength and prosodic structure, it is widely established that strong consonants (here: fortis obstruents) are preferred at prosodic boundaries, while weak consonants (here: lenis obstruents, sonorants) are preferred at prosodic boundaries (e.g., Honeybone 2012, Katz 2016). We utilize these insights, but, as indicated in the introduction, we question the traditional assumption that lenition is necessarily top-down. Instead we propose that, at least in certain Franconian dialects, word-medial consonants regulate foot structure. Specifically, we claim that word-medial lenis consonants will always be foot-medial, whereas word-medial fortis consonants typically block the formation of a foot across that consonant, thus blocking it from occurring in a foot-medial onset position. The respective resulting surface structures are shown in 4a and 4b, respectively, where 4a with the lenis consonant is parsed as a disyllabic Accent-1 foot, and 4b with a fortis consonants is parsed as a bimoraic, monosyllabic Accent-2 foot. Accordingly, the lenis consonant in 4a occurs foot-medially, but the fortis consonant in 4b is located outside of the foot, both of which is in line with general tendencies observed in traditional lenition processes.

- (4) Influence of consonantal strength on foot structure in Franconian for Cologne
[i:¹.zə] ‘iron’ ~ [ri:².sə] ‘tear’



These patterns can be formalized in OT as follows. First, we assume that disyllabic sequences are preferably parsed as disyllabic feet, which is enforced by a constraint PARSE-SYL (5):

- (5) PARSE-SYL: Assign a violation for every syllable that is not parsed by a foot.

PARSE-SYL must be outranked by a constraint that prohibits fortis consonants in foot-medial position, as defined in (6):

- (6) *FOOT-MEDIAL FORTIS (*FMF): Assign a violation mark for every foot-medial fortis consonant.

These two constraints suffice to account for predictable interactions of consonantal strength and foot structure. As shown in (4), foot-medial lenis consonants will lead to a disyllabic Accent-1 foot (vacuously satisfying *FMF, satisfying Parse-Syl). Example (7) demonstrates that *FMF must outrank PARSE-SYL, which correctly predicts that items with

word-medial fortis consonants will be footed as monosyllabic feet, followed by an unparsed second syllable (= Accent 2) since a disyllabic foot would violate *FMF. In all tableaux, syllables boundaries will be represented with a period and foot structure will be indicated with parentheses.

- (7) Items with word-medial lenis consonants are footed as a disyllabic Accent-1 trochee

i:zə	*FMF	PARSE-SYL
a. → (i:zə)		
b. (i:).zə		*!

- (8) Items with word-medial fortis consonants are typically footed as a bimoraic Accent-2 trochee

ri:sə	*FMF	PARSE-SYL
a. → (ri:sə)	*!	
b. (ri:).sə		*

As discussed in §2.2, there is a distinct set of etymologically non-long vowels that surface with Accent 1, that is, with a disyllabic trochee. To account for this set of words, we employ a claim in Köhnlein 2016, who has argued on the basis of unrelated distributional facts that Accent 1 can be lexically stored as a disyllabic, trochaic foot template. Following Köhnlein’s approach, such templates are protected by a high-ranked faithfulness constraint HEADMATCH-Ft (McCarthy 1995, 2000; Köhnlein 2016; Köhnlein and Zhu 2019), as defined in (9):

- (9) HEADMATCH-Ft: Assign a violation mark for every element that is a foot head underlyingly but is not a foot head on the surface.

High-ranked HEADMATCH-Ft will preserve an input disyllabic foot, even if this means that *FMF will have to be violated. This is demonstrated in (10) for the item [ʃlo:¹fə] ‘to sleep’. Crucially, such forms demonstrate that the segment-foot interactions in question are bottom-up and not top-down; if they were top-down lenition, we would expect [ʃlo:¹fə] to either surface with Accent 2 or with Accent 1 and an intervocalic lenis consonant. To ‘save’ a lenition approach, one might consider to postulate to types of fortis consonants, a weaker one that lenites and a stronger one that surfaces faithfully. Phonetically, however, there does not appear to be any evidence supporting such a claim, and such an approach would thus be merely diacritical in nature.

(10) Items with word-medial fortis consonants and lexically stored Accent-1 trochees

	[flo:fə] + (‘σ.σ)	HEADMATCH-FT	*FMF	PARSE-SYL
a.	→ (flo:fə)		*	
b.	(flo:).fə	*!		*

In summary, this subsection shows how segment-based footing can be formally accounted for. In what follows, we demonstrate that tonal and durational patterns in Franconian dialects are perfectly in line with our claims.

3.2 Tone and foot structure

As indicated in §2.1, Accent 1 and Accent 2 in Franconian display contrastive tonal melodies (hence the name tonal accent). The tonal contrasts have been formally treated in various metrical approaches to tonal accent, such as Hermans (2012), Kehrein (2017) or Köhnlein (2011, 2016, 2018), or van Oostendorp (2018). Here, we pursue Köhnlein’s approach, which, as we show, is perfectly in line with our analysis of the segment-based foot structures discussed in §3.1. We illustrate our analysis of tonal association for Cologne Franconian, based on phrase-medial position and declarative intonation. For a detailed analysis and formalization of the Cologne tonal system, consider Köhnlein (2011, 2016).

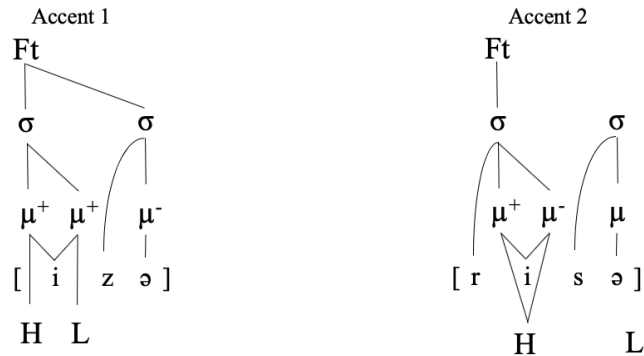
As we have shown in Figure 1, Accent 1 in Cologne in phrase-medial declaratives is realized as a falling tone, and Accent 2 is realized as a high-level tone with a post-tonic fall after the stressed syllable (e.g., Peters 2006; similar contours can very likely be assumed for Aegidienberg, but detailed phonetic studies for this variety are missing). Roughly, the Cologne system preferably allows two tones in Accent-1 syllables but only one tone in Accent-2 syllables. This, as Köhnlein argues, follows from the foot structure of Accent 1 and Accent 2, respectively. In this approach, the head of a foot is determined at the highest level where the foot can be binary (see Morrison 2019 for a very similar approach to tonal accent in Scottish Gaelic). Following traditional assumptions in metrical theory, feet can either be based on syllable or mora count (Hayes 1995).

For Accent 1, which in the data under discussion corresponds to a disyllabic foot with a foot-medial lenis consonants, is binary at the syllable level – accordingly, the head of the foot is the first syllable; this is shown in 11a, where headedness is indicated with a superscript plus for illustration. Crucially, both moras in the stressed accent syllable are dominated by the head and, as we argue, they inherit the strength of the syllabic head at the foot level (Köhnlein refers to this as a ‘head domain’). In Cologne Franconian, only such strong moras can license intonational tones; since both moras in a stressed Accent-1 syllable are strong, both tones of the declarative pitch accent H*L can be realized in the accent syllable. As shown in (11a), H* goes to the first mora, and L goes to the second mora.

The situation is somewhat different for Accent 2, which is a monosyllabic foot (11b). Accordingly, the foot cannot be binary at the syllable level, but it still contains two moras, so binarity occurs at the mora level. Accordingly, the first mora of the accent syllable will be the foot head and metrically strong at the foot level, and the second mora will be the dependent and weak. With regard to the tonal mapping, this means that only one

intonational tone can be licensed in the accent syllable (tonal contours are disfavored). Accordingly, H* can associate to the first mora, but L cannot be associate to the second mora. Instead, H* spreads to the second mora, and L must be realized in a post-tonic syllable (the precise details of which depend on the structure of the post-tonic domain). The basic analysis would be the same for interrogatives, where a L*H pitch accent realizes both tones in Accent-1 syllables (leading to a rising tone), but only L* in Accent-2 syllables (leading to a level tone with a post-tonic rise).

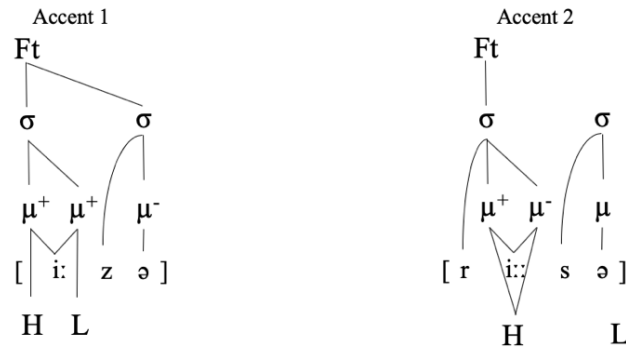
(11) Tonal mapping for Accent 1 and Accent 2, phrase-medial declarative intonation



3.3 Duration and foot structure

In addition to tone, Cologne Franconian (and many other Franconian dialects) also displays systematic durational differences between the accents: Accent 2 is substantially longer than Accent 1 (Peters 2006 for data). In prominent sentence position, these durational differences accompany the tonal contrast; in post-tonic position, however, the durational difference between shorter Accent 1 and longer Accent 2 is the distinctive correlate between the accents, rather than tone. As argued in Köhnlein 2016, this aspect of tonal accent can be straightforwardly expressed in a foot-based analysis – after all, duration as a correlate of foot structure is unsurprising. In the approach defended here, we can assume that a foot can be assigned a certain phonetic duration, which is then distributed across the elements of the foot; as we discuss in more detail in §4, this is perfectly in line with previous claims on the analysis of overlength in Estonian (Prince, Odden). With regard to Franconian, this principle can be applied as follows. Accent 1, the disyllabic foot, distributes the duration of a foot across two syllables; Accent 2, the monosyllabic foot, will distribute its duration over only one syllable. Accordingly, Accent 2 will have a longer stressed syllable (whole duration of the foot) than Accent 1, where only some of the duration of the foot is realized in the stressed accent syllable. The durational correlates and their relationship to the surface structures are shown in (12), together with the tonal opposition.

(12) Tonal and durational correlates of the opposition between Accent 1 and Accent 2



In summary, this section has demonstrated that tonal accent in Franconian can have multiple correlates that interact with one another, such as word-medial consonant strength, tone, and duration. We have argued that these interactions can be straightforwardly accounted for in an approach where Accent 1 is analyzed as a disyllabic foot, and Accent 2 as a monosyllabic, bimoraic foot.

4. Estonian parallels

Our analysis of the segmental-metrical interactions in Franconian has parallels in Estonian, namely in previous analyses of overlength by Prince (1980) and Odden (1997). Estonian is a language known for its ternary quantity contrast, as provided in (3) below.

(13) Ternary quantity in Estonian

- a. [sata] ‘hundred’ (Q1)
- b. [saata] ‘send, imperative’ (Q2)
- c. [saa:ta] ‘to receive’ (Q3)

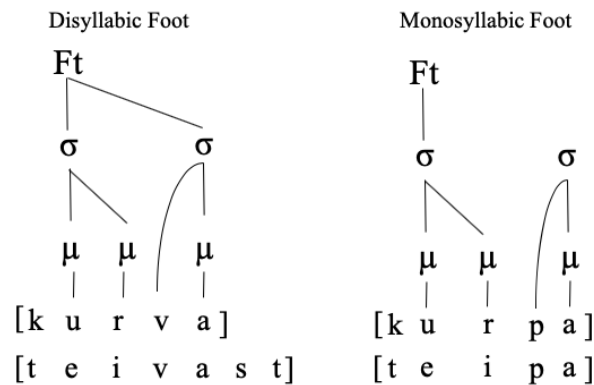
Previously, this ternary contrast presented a challenge to the assumption that phonological contrasts are necessarily binary, suggesting three degrees of underlying phonemic length. The metrical analyses proposed by Prince and Odden retain binarity by proposing two contrastive foot structures, such that ternary quantity derives from the phonetic realization of a foot: The duration of the monosyllabic foot is expressed in only one syllable, leading to ‘overlength’ (Q3); in Q2, the duration of the foot spreads over two syllables, leading to ‘normal length’.

Estonian also features morphophonological alternations, known as gradation, characterized by the strong grade (typically with word-medial fortis consonants), and the weak grade (typically with word-medial lenis consonants). In a metrical analysis, the disyllabic foot corresponds to the weak grade, and the monosyllabic foot corresponds to the strong grade. Two examples are provided in (14), which shows the genitive and partitive inflections of the words for ‘sad’ and ‘pole’.

- (14) Estonian consonant gradation
- | | | |
|-----------|--------|---------|
| | ‘sad’ | ‘pole’ |
| gen. sg. | kurva | tei:pa |
| part. sg. | kur:pa | teivast |

The gradation facts can be accounted for by stating that word-medial consonants in the disyllabic foot are preferably lenis, whereas word-medial obstruents, which are outside the domain of the foot, are preferably fortis (see Prince 1980, Odden 1997), as shown in Figure 2—exactly as we claim for Franconian.

Figure 2. Voicing, foot structure, and tonal mapping for Q2 (left) and Q3 (right) in Estonian gradation



There are two more parallels between Estonian and Franconian. First, as described in Gussenhoven and Peters 2004 and Peters 2006, Accent-2 syllables (the monosyllabic foot in our approach) is significantly longer than Accent-1 syllables (part of the disyllabic foot) in Cologne Franconian, which parallels Prince’s and Odden’s analysis of Estonian quantity. Furthermore, it has long been observed that the Estonian H*L contour is distributed over two syllables in Q2, while the locus of the H*L contour is entirely in the first syllable for Q3 (Lehiste 1997, among many others; representations in (4)). Comparing Figure 1 to Figure 2 reveals that this is the opposite tonal mapping than in, for example, Cologne; yet descriptions of other Franconian dialects (e.g., Arzbach Franconian; Bach 1921, Köhnlein 2011) show similarly ‘reversed’ melodies. Following Köhnlein (2011, 2016), the Arzbach system can be analyzed by assuming that strong moras, which are linked to the head position of a foot, avoid low tone (*HEAD/L; de Lacy 2002), so that L will have to be realized on weak moras. As shown in (15), prohibiting H from associating to strong moras also successfully accounts for the Estonian facts.

(15) Tonal mapping in Estonian

Q2		Q3	
σ	σ	σ	σ
			
H*	L	H*	L
(μ^+ μ^+)	(μ^-)	(μ^+ μ^-)	μ

5. Conclusion

This paper has aimed to contribute to ongoing debates regarding the interaction of voicing and metrical structure, as well as the phonological representation of tonal accent. We have argued that word-medial consonantal strength can determine foot structure in certain Franconian dialects, counter to existing claims that such interactions can only occur in a top-down manner. We have shown that three co-existing correlates of accent (next to consonantal strength, we have discussed tonal patterns and duration) can all be attributed to a difference between disyllabic feet (Accent 1) and monosyllabic feet (Accent 2). Subsequently, we showed that very similar patterns can be found in the distribution of Estonian overlength, and that these patterns have also been analyzed in a foot-based approach. While we believe that the case for a foot-based analysis is generally strong (aside from the interactions discussed in this paper), it should be mentioned that formalizations with lexical tone have been proposed for tonal and durational correlates. Here, we restrict ourselves to some remarks about the segmental effects discussed here, while tone and duration are discussed in, for example, Köhnlein 2016—note also that Gussenhoven and Peters (2019) attempt to make the case in favor of a tonal analysis of Franconian accentuation.

With regard to the segment-accent interactions at the core of this paper, we believe that in an approach with lexical tone, it would appear to be very difficult to express the emerging generalizations in a straightforward manner. Crucially, Accent-1 syllables realized as H*L in declaratives and L*H in interrogatives; likewise, Accent-2 syllables can be realized as a high-level tone or a low-level tone in declaratives and interrogatives, respectively. This implies that for both accents, the tone preceding the foot-medial consonant is sometimes H and sometimes L, which makes it impossible to postulate any generalization about interactions between surface tones and consonantal strength. For this reason, we believe that the interactions discussed here are hard to implement into an approach with lexical tone in an insightful manner. At the same time, they appear to follow straightforwardly from a metrical representation of tonal accent.

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