The complex durational relationship of contour tones and level tones

Evidence from diachrony*

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The production of a contour tone requires a longer duration than the production of a level tone. This paper demonstrates that this durational relationship becomes considerably more complex when tones are realized on bimoraic sonorant units that can support both level tones and contour tones. Evidence comes from diachronic processes in which pitch and duration interact. In languages where (intrinsic) durational differences between two groups of bimoraic units lead to tonal contrasts, the longer units commonly receive a contour tone, and the shorter ones a level tone; yet over time, the units with the fully developed contour tone tend to shorten, and those with the level tone tend to lengthen. Ultimately, this can even lead to durational reversals between the units in question. The discussion focuses primarily on Franconian tone accent dialects but also incorporates data from Estonian, Hup, Las Norias Piman and North Low Saxon.

Keywords: tonogenesis; relationship between tone and duration; tone accent; overlength; phonetics-phonology interface; vowel shortening; vowel lengthening

1. Introduction

In the description and analysis of linguistic tone, scholars commonly differentiate between 'level tones' and 'contour tones'. In autosegmental phonology (Leben 1973; Goldsmith 1976), a level tone constitutes a single tonal target in the speech stream, such as a high tone (H) or a low tone (L). Contour tones, on the other hand, are prototypically derived from the combination of non-identical single tones. For instance, a falling tonal movement from a high to a low target is usually regarded as the phonetic implementation of H and L, and a rising movement from

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a low to a high target corresponds to a sequence of L and H. This paper discusses the complex relationship between level tones/contour tones and their respective duration in Estonian, Franconian, Hup, Las Norias Piman and North Low Saxon. The focus will be on (a) how the phonetic relationship between tone and duration can change over time and (b) what consequences this has for the phonological systems of the languages in question.

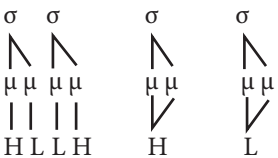
From a phonetic perspective, producing a contour tone takes longer than producing a level tone. The speaker has to manipulate the fundamental frequency (F0) of the speech signal, which involves considerable articulatory effort, such as significant changes in the vibration of the vocal cords (see Ohala 1978 for a detailed discussion). As a consequence of the necessary articulatory effort, contour tones have a longer minimum duration than level tones (see, e.g. Greenberg & Zee 1979; Gordon 1999, 2002, 2006; Zhang 2001) – as Zhang (2001: 34) puts it, "[t]he greater the number of pitch targets of a tone, the longer duration it requires". A straightforward example of this effect is shown in Gordon (2006) for Hausa. Hausa allows level tones (H, L) and falling tones (HL) on short vowels (V) followed by coda obstruents (O). VO syllables with a falling tone undergo phonetic lengthening to enable the realization of the tonal contour (the average durations are 112 ms for H, 105 ms for L and 133 ms for HL; Gordon 2006: 91–92).

It seems less clear, however, what the durational relationship between contour tones and level tones is once these tones are realized on units that are long enough to comfortably support level tones AND contour tones. Is there one tonal configuration that will (prototypically) be phonetically longer, can any of them be longer/shorter (depending on the language) or will level and contour tones have (more or less) the same duration? To the best of my knowledge, these questions have not received any systematic attention to date; yet Yu (2010: 151), for instance, states that "contour tone syllables are generally longer than flat tone syllables".

This paper aims to demonstrate that the durational relationship between simplex and contour tones is considerably more complex than has been discussed so far. In a nutshell, the key claim is that in some languages, durational contrasts between level tones and contour tones can vary as a function of the 'linguistic age' of a tonal contrast, that is, the period of time since the contrast entered the language. In some systems with a 'younger' tone contrast, contour tones are phonetically longer than level tones. When such systems age, however, the durational differences can decrease or can even be reversed; there can even be cases where, in the present day system, originally longer contour tones are now shorter than originally shorter level tones. The focus of the discussion will be on Franconian (spoken in parts of Belgium, Germany and the Netherlands), where such a durational reversal has taken place. Furthermore, the paper shows that earlier stages of the proposed developments can be found in Estonian, Hup, Las Norias Piman and North Low Saxon.

As a first step, let me define the prosodic contexts we are going to look at: I will focus on the durational development of simplex tones and complex tones on syllables whose rhyme is long enough to comfortably support both level tones and contour tones, and where no phonological restrictions prohibit the realization of contour tones (such as constraints against multiple tones on a single syllable). In phonological terms, I refer to the relevant units as 'bimoraic sonorant units', which occur in the rhyme of the same syllable and contain either a long vowel/diphthong, VV(C) or a short vowel followed by a sonorant, VR(C). (1a) shows two contour tones on such a domain, HL and LH, which display a one-to-one association of tones to tone-bearing units (TBUs, here: moras); this leads to a falling tone (HL) or to a rising tone (LH). In (1b), we see two level tones (H, L) that are associated with two TBUs (due to tonal spreading); this results in either a bimoraic high level tone or a bimoraic low level tone, respectively.

(1) a. Contour Tone b. Level Tone



As we shall see, when we compare the duration of these groups across different languages, we find mixed evidence concerning the relationship between bimoraic contour tones and bimoraic level tones: contour tones can either be shorter or longer than level tones. The central claim of the paper is that this relationship thus might seem cross-linguistically arbitrary from a purely synchronic perspective, but it is NOT arbitrary when we take into account the diachronic development of tonal contrasts in the respective languages. The relationship depends on which of the two factors is dominant in a system at a given point in time: that is, the question is whether DURATION influences PITCH, or whether TONE influences DURATION.[1]

Table 1 summarizes a possible path of sound change discussed in this paper. I provide arguments that in languages where durational differences lead to the introduction of a phonological tonal contrast, the unit with the longer duration will prototypically develop a contour tone, and the unit with the shorter duration will develop a level tone; the reason is that the longer syllable can host a more

1. A note on terminology: With the term pitch/pitch contrast, I refer to 'purely' phonetic contrasts, i.e. to contrasts that are not exploited by the phonology. With the notion tone/tonal contrast, I shall refer to phonologized/phonological contrasts. Likewise, I use the term duration/durational contrast for phonetic contrasts, and length/length contrast for phonologized/phonological oppositions of monomoraic versus bimoraic vowels.

extensive (phonetic) pitch movement than the shorter one. This redundant pitch difference can then be reinterpreted as a (phonological) tonal contrast. Since, in such a scenario, differences in duration between two groups of sonorant bimoraic units are responsible for the introduction of a tonal contrast, I shall refer to this as a 'duration-based genesis' of a tonal opposition. The proposed developments are reflected in Stages 1–3 in Table 1.

Once such a tonal contrast is fully developed, however, the originally shorter unit with the level tone will tend to (gradually) lengthen, and/or the originally longer unit with the contour tone will tend to shorten. Over time, this can even lead to a durational reversal; in such a case, the originally longer unit is synchronically shorter than the originally shorter one – the shape of the tones influences duration (Table 1, Stages 4–5). This seems to imply that, ceteris paribus, contour tones on bimoraic sonorant units are phonetically shorter than level tones, counter to the claim in Yu (2010). As we shall see, there are good reasons to assume that this is indeed the case.

Table 1. Five developmental stages in interactions between tone and duration on two types of bimoraic sonorant units (represented as Class 1 and Class 2)

Stage	Process	Description
1	Durational contrast	Bimoraic Class 1 has a phonetically longer duration than bimoraic Class 2
2	Pitch contrast	Longer Class 1 correlates with stronger pitch movements than shorter Class 2
3	Tonal contrast	Longer Class 1 develops a contour tone, shorter Class 2 a level tone
4	Durational adjustment	Weakening of the original durational contrast through shortening of Class 1 under the influence of the contour tone and/or lengthening of Class 2 under the influence of the level tone
5	Durational reversal	Originally longer Class 1 is phonetically shorter than originally shorter Class 2

Let me briefly illustrate the five stages with data from Franconian, which has ternary durational contrasts between phonetically short, phonetically long and phonetically overlong syllables, as well as a binary tonal contrast on long and overlong syllables with two sonorant moras (more background on the language will be given in §2): for instance, in the dialect of Cologne, the singular and plural forms for the word "certificate", [ʃiŋ], are segmentally identical but can be distinguished on the basis of their tonal melodies and their duration. The precise shape of the tones varies with pragmatic context and sentence position; in phrase-medial

declaratives, the singular has a bimoraic high level tone, [ʃi^{H}ŋ^{H}], and the plural has a bimoraic falling tone, [ʃi^{H}ŋ^{L}]. Crucially, level-toned forms are phonetically LONGER than forms with falling tone in the synchronic system; yet the lexical distribution of the opposition provides compelling evidence that this has not always been the case, and that Franconian has undergone a 'durational reversal' over time: syllables with contour tone apparently were once LONGER than syllables with level tone, unlike what we find in the modern system. I return to this issue in §§2 and 3. As we shall see, diachronic processes in Estonian (§4.1), North Low Saxon (§4.2), Las Norias Piman and Hup (both in §4.3) correspond to earlier, reconstructed stages of Franconian and thus complete the picture.

In the literature, prosodic systems like Franconian have been described with various terms, such as 'accentual systems', 'pitch accent systems', 'tone accent systems' or 'restricted tone systems'.[2] As a descriptive notion and to minimize terminological confusion, I shall refer to Franconian and similar languages throughout this paper as 'tone accent systems'. In a nutshell, what is distinctive about the use of tone in tone accent systems is (a) the strong connection between the tonal opposition and stress, as well as (b) the limited number of tonal contrasts. With regard to (a), tonal contrasts in Franconian only occur in stressed syllables. Furthermore, they are accompanied by differences in duration, which is a classical feature of stress languages. With respect to (b), tone accent systems never contrast more than two types of words by means of tone – in other words, tonal oppositions in tone accent systems are ALWAYS binary/privative. In some way, these languages thus behave similar to what one might intuitively consider 'prototypical' tonal systems (as for instance in many African or Asian languages), in the sense that contrastive tonal melodies can change the meaning of words. On the other hand, they are also comparable to 'prototypical' stress systems, since the tonal contrasts are parasitic on word stress and enhanced by correlates other than tone.

There is a long-standing debate concerning how tone accent systems fit in the typology of prosodic systems. The main issue is whether they should be considered a special type of tone system, as a special type of stress system, whether they should form their independent typological category (possibly as a subgroup of pitch accent systems) or perhaps any attempts at classification are inadequate to begin with (for recent contributions, see e.g. Hyman 2006, 2009, 2011, Beckman & Venditti 2010, 2011, Van der Hulst 2011, 2012; Hualde 2012). I return to the issue in §5, where I discuss to which degree the phenomenon in question may contribute

2. Following Fikkert & Jacobs (2003:1), I define a prosodic system as "the set of organizing principles that govern suprasegmental structure, that is, the structure above the individual sounds of the language."

to the discussion. In brief, I argue that the duration-based genesis of tonal oppositions is limited to stressed syllables, and thus to languages with word stress.

The paper is structured as follows: §2 provides a brief introduction to the default phonetic relationship between tonal melodies and their duration. It discusses data from Franconian and three other tone accent languages (Lithuanian, Livonian, Serbo-Croatian), as well as evidence from experiments on perceived duration. §3 addresses the development of the Franconian tone accent contrast, where a durational contrast between long and overlong bimoraic units led to a tonal opposition. In §4, I discuss evidence from Estonian indicating that the system has arrived at Stage 4. Moreover, reports from North Low Saxon suggest that some varieties have developed a tonal contrast alongside a ternary quantity opposition. Additional evidence for the early stages of the proposed developments comes from Las Norias Piman and Hup. Lastly, §5 discusses potential phonetic explanations for the observed patterns as well as possible implications for the typology of prosodic systems. §6 concludes.

2. Synchronic interactions between tone and duration in Franconian and elsewhere

This section aims to establish the default (phonetic) duration of bimoraic sonorant units as a function of their (phonological) tone (contour tone vs. level tone). I begin by discussing synchronic patterns in Franconian, continue by relating them to similar languages and also provide relevant evidence from experiments on the perception of duration under the influence of tone/pitch.

As briefly mentioned in the introduction, Franconian displays a prosodic opposition between two tone accents, which I refer to as Class 1 and Class 2.[3] The accents occur only in stressed syllables, and the opposition can serve to distinguish lexical items and morphological units. In (2), I provide four minimal pairs from the Mayen dialect (data from Schmidt 1986); Class 1 is indicated with a 'c1' superscript, Class 2 with a 'c2' superscript:

(2)	a.	[haus^{c1}]	"house-DAT"	[haus^{c2}]	"house-NOM"
	b.	[tɔʊf^{c1}]	"pigeon"	[tɔʊf^{c2}]	"baptism"
	c.	[ʃdaːn^{c1}]	"stone-PL"	[ʃdaːn^{c2}]	"stone-SG"
	d.	[man^{c1}]	"basket"	[man^{c2}]	"man"

3. This terminology differs from 'traditional' terminology where the accents have been referred to as Accent 1 and Accent 2, after Schmidt (1986). For the purposes of the present paper, this choice is largely irrelevant; yet it is motivated by Köhnlein (2011:6–7).

The two accents are primarily distinguished by their tonal melodies, as shown in Werth (2011) by means of perception experiments. In most dialects, the accent opposition can only be realized on items that have two sonorant moras in their stressed syllable (either a long monophthong, a diphthong or a short vowel followed by a sonorant consonant). The shape of the tonal contours varies across dialects as well as within them: it is influenced by the pragmatic context (e.g. declaratives, interrogatives), relative prominence (focus, non-focus) and the position in the phrase (final, non-final). In the majority of dialects (so-called Rule A, as opposed to Rule B; see below for further discussion), Class 1 commonly correlates with contour tones, and Class 2 with level tones. In Figure 1, this is shown for phrase-medial declaratives and interrogatives in the Rule A dialect of Cologne (data from Peters 2006).

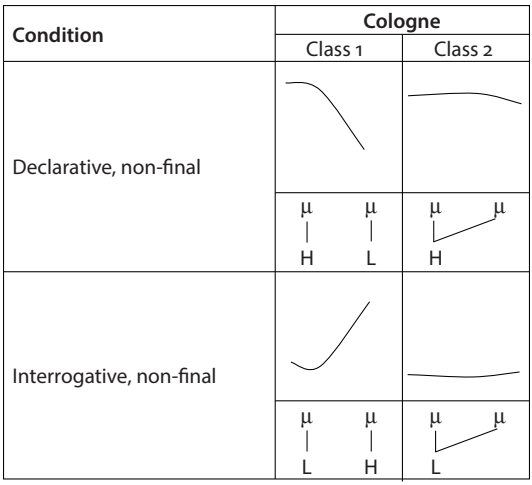


Figure 1. Tonal melodies of the tone accents in the Cologne dialect, phrase-medial position

Figure 1 indicates that in phrase-medial declaratives, a falling tone (HL) in Class 1 syllables corresponds to a high level tone (H) for Class 2. In interrogatives, a rising tone for Class 1 (LH) corresponds to a low level tone for Class 2 (L). In the figure, the horizontal dispersion of the Class 1 contours is somewhat narrower than that of Class 2. This serves to indicate the relative shortness of Class 1 contours: in phrase-medial position, the rhymes of level-toned Class 2 syllables are on average 34.7 percent longer than those of Class 1 syllables (Peters 2006: 121). This durational relationship is by no means an idiosyncratic feature of the Cologne dialect. It can be observed in a variety of other dialects, such as Hasselt (Peters 2008), Mayen (Schmidt 1986; Werth 2011), Roermond (Gussenhoven 2000a) and Sittard (Hanssen 2005), just to name a few.

The connection between contour tones and relatively short duration can also be observed in Franconian Rule B, a variety spoken in the southwest of the tone accent area. In declaratives, Rule B has reversed tonal melodies in comparison to Rule A (Bach 1921; Köhnlein 2011, 2013, 2015). That is, items from Class 1, such as the word [man^{c1}] "basket", have HIGH LEVEL TONE in declaratives (as opposed to FALLING TONE in Rule A); Class 2 items, such as [man] "man^{c2}", have FALLING TONE (as opposed to HIGH LEVEL TONE in Rule A). Crucially, as shown in Köhnlein (2011), Class 2 (falling tone) is phonetically SHORTER than Class 1 (level tone). This shows that the general phonetic relationship between tone and duration is governed by the synchronic shape of the tones, rather than by (etymological) accent class. We can conclude that on bimoraic sonorant units in Franconian, contour tones (HL, LH) correlate with relatively short duration, and level tones (H, L) with relatively long duration.

There are strong indications that this constitutes a more general pattern, at least across tone accent systems: Lehiste & Ivić (1986: 61) show that in Serbo-Croatian, the long falling accent (HL) has a shorter duration than the long rising accent (which, at least in the variety Lehiste & Ivić discuss, is realized as a high level tone rather than as a true rise). Furthermore, Livonian displayed a contrast between falling tones and level tones on bimoraic units; once again, the falling tone is phonetically shorter than the high level tone, which Kiparsky (forthcoming) links to the falling tonal contour. Dogil & Williams (1999: 278–284) report for Lithuanian that the circumflex accent (with a relatively earlier fall) has a shorter duration than the acute accent (with a relatively later fall). As a reviewer correctly points out, the tonal opposition is only a weak correlate of the opposition in modern Lithuanian – still, a tonal contrast IS present in the data (and was certainly there historically).

There may also be some more general, perceptual evidence in favor of the default correlation between contour tone/relatively short duration and level tone/relatively long duration on bimoraic sonorant domains: while, to the best of my knowledge, there are no systematic cross-linguistic PRODUCTION studies on the matter, considerable effort has been put into studying the PERCEIVED duration of contour tones and level tones. In such perception studies, it has often been found that units with contour tone/dynamic F0 are perceived as longer than units of equal duration with level tone/steady F0 (Lehiste 1976; Pisoni 1976; Yu 2010; Cumming 2011, Gussenhoven & Zhou 2013); it should be noted, however, that there are also studies where no systematic perceptual effect is reported for at least some experimental conditions (e.g. Rosen 1977, Lehnert-LeHouillier 2007).

If indeed, at least as a default, contour tones are shorter than level tones on bimoraic sonorant units, then the perceived longer duration of contour tones is probably a result of 'hypercorrection': that is, listeners can compensate for certain

articulatory effects in speech production (Ohala 1993). For instance, Gussenhoven (2007) shows that listeners perceive higher vowels as longer than lower vowels when they are of equal acoustic duration. Since lower vowels are intrinsically longer than higher vowels, this demonstrates that listeners compensate for the articulatory effect. Notably, Gussenhoven & Zhou (2013) claim that similar compensatory mechanisms also apply with respect to the relationship between contour tones and level tones – they argue that contour tones are acoustically shorter than level tones (based on data from Chinese) but will be perceived as longer, which is in line with the data reviewed in this section.[4]

In sum, we have established that bimoraic units with contour tones tend to be phonetically shorter than bimoraic units with level tones in several languages, an effect that may be supported by general perceptual mechanisms. Yet, as we shall see in the following sections, the relationship in question is more complex than has been established so far.

3. The history of tone and duration in Franconian

3.1 The genesis of the tone accent contrast: Duration influences pitch

In §2, we saw that in most dialects of Franconian (so-called Rule A), Class 1 syllables have contour tones and a relatively short duration, and Class 2 syllables have level tones and a relatively long duration – this is in line with the general tendencies established so far. Yet, as this section demonstrates, there is compelling distributional evidence indicating that the durational relation between Class 1 and Class 2 has not always been this way: rather, the diachronic distribution of the accents suggests that at the initial stages of the opposition, Class 1 (contour tone) was LONGER than Class 2 (level tone). Note that there is some (limited) distributional variation across dialects, which is relevant for determining the precise diachronic typology of the accent opposition (see Köhnlein 2011 for the distributional details in different dialect areas). For the purposes of this paper, however, I abstract away from some details and restrict myself to the lexical distribution of Rule A, as spoken in large parts of the area (for instance, in Cologne). This distribution is shown in Table 2, based on a Middle High German (MHG) reference system (examples from Münch 1904 for Cologne are provided in footnotes).

4. Yu (2010) claims, however, that there is no perceptual compensation for level tones vs. contour tones, which derives from his assumption that both the acoustic and the perceived duration of syllables with contour tones are longer than those of syllables with level tones (see §1).

Table 2. Lexical distribution of the tone accents for Rule A, based on a MHG reference system

Class 1		
Phoneme group in MHG	**Original context**	
Long mid and low vowels, opening diphthongs	all[5]	
Long high vowels Closing diphthongs Short vowels + sonorant Lengthened vowels	+ voiced onset + schwa[6]	
Class 2		
Phoneme group in MHG	**Original context**	
Long high vowels Closing diphthongs Short vowels + sonorant Lengthened vowels	monosyllabic word[7]	+ voiceless onset + schwa[8]

Table 2 shows the distribution of the accents across units with two sonorant moras in the stressed syllable, as first described in Nörrenberg (1884). Starting from the top of the table, the first crucial aspect to note is that MHG long mid and low vowels and opening diphthongs always belong to Class 1, independent of the context they occur in. This distinguishes them from other phoneme groups, which can belong to either Class 1 or Class 2 (MHG long high vowels, closing diphthongs, short vowels + sonorant, lengthened vowels). For these other groups, class membership is determined by the context they appear in. To begin with, all

5. [kliːᶜ¹], MHG *klê* "clover"; [luːnᶜ¹], MHG *lôn* "wages"; [leːtᶜ¹], MHG *lied* "song"; [hoːtᶜ¹], MHG *huot* "hat"; [ɔːsᶜ¹], MHG *âs* "carrion".

6. [ʃruːfᶜ¹], MHG *schrûbe* "screw"; [driːᶜ¹və], MHG *trîben* "to drift"; [meːᶜ¹nə], MHG *meinen* "to mean"; [ʃteːnᶜ¹], MHG *steine* "stone-DAT"; [kanᶜ¹], MHG *kanne* "can"; [biᶜ¹ŋə], MHG *binden* "to tie"; [ʃlaːᶜ¹ɣə], MHG *slagen* "to punch"; [beiᶜ¹], MHG *bine* "bee".

7. [bɔuᶜ²], MHG *bû* "building"; [huːsᶜ²], MHG *hûs* "house-NOM"; [droːmᶜ²], MHG *troum* "dream"; [ʃteːnᶜ²], MHG *stein* "stone"; [fiŋkᶜ²], MHG *fink* "finch"; [dɑmpᶜ²], MHG *tampf* "steam"; [flaːsᶜ²], MHG *vlahs* "flax"; [daːlᶜ²], MHG *tal* "valley".

8. [riːfᶜ²], MHG *rîfe* "frost"; [ʃliːᶜ²fə], MHG *slîfen* "to polish"; [meːᶜ²stɐ], MHG *meister* "master"; [loːᶜ²fə], MHG *loufen* "to run"; [bliŋᶜ²kə], MHG *blinken* "to blink"; [viŋkᶜ¹tɐ], MHG *winter* "winter"; [kaːᶜ²stə], MHG *kasten* "box"; [hɔuᶜ²fə], MHG *hoffen* "to hope".

originally monosyllabic words of these groups belong to Class 2 synchronically. In disyllabic words, it is the voicing quality of the onset consonant in the post-tonic syllable that determines class membership; the post-tonic syllable always contains a schwa. In cases where this word-medial consonant was voiceless in MHG, the corresponding item belongs to Class 2 synchronically. When the consonant was voiced, the item now belongs to Class 1 (voiced obstruents, sonorants).

It is the merit of Bach (1921) to have observed the crucial difference between Class 1 and Class 2. Based on findings by Meyer for German (Meyer 1896–1897) and English (Meyer 1903), Bach suggests that Class 1 vowels must have been intrinsically LONGER than Class 2 vowels at the time when the accent genesis took place. In his work, Meyer had established that long mid and low vowels are phonetically longer than long high vowels and short vowels; furthermore, he found that vowels are longer before voiced intervocalic consonants than in monosyllabic words/before voiceless intervocalic consonants. As noted by Bach, applying Meyer's findings to Franconian makes it possible to unite the different phoneme groups belonging to Class 1 and Class 2.

None of these durational patterns is uncommon across languages: for instance, long mid and low vowels often behave differently from high vowels in terms of quantity, as already noted in Jespersen (1913: 181–182). That is, there are various systems where high vowels cannot be (phonologically) long but mid and low vowels can (Laver 1994; Miglio 1999, 2005; Gussenhoven 2009). At the same time, it has been repeatedly shown that consonant voicing can affect the duration of preceding vowels, which is now commonly referred to as 'pre-fortis clipping' (Wells 1981 for English) or as 'pre-lenis lengthening'.

Interestingly, both of these intrinsic durational factors have played a role in the development of High Prussian, a variety of East Central German (Stuhrmann 1895–1898, Kuck 1925, Kuck & Wiesinger 1965; Teßmann 1969): originally long high vowels were shortened when followed by obstruents surfacing as voiceless, while they stayed long when followed by voiced obstruents. This is shown in (3a) for the alternation between "song-SG" and "song-PL", where both vowels historically derive from a long /iː/ (Kuck & Wiesinger 1965: 130–131). Crucially, however, this shortening process did not apply in the case of long mid and low vowels, which always stayed long, even when followed by a voiceless obstruent (3b, left side). Notice that all voiceless obstruents in (3) are due to final devoicing; yet underlying voiceless obstruents affected preceding vowels in the same way. As we can see, the combined effects of vowel height and obstruent voicing are quite similar to what we find in Franconian – except that High Prussian did not develop a tonal contrast.

(3) a. [lɪt] "song-SG" vs. [liːdɐ] "song-PL"
b. [kleːt] "dress-SG" vs. [kleːdɐ] "dress-PL"

In sum, the duration-based look at the lexical distribution in Franconian reveals that, from a diachronic perspective, phoneme groups with originally longer duration pattern together as Class 1, in opposition to originally shorter units (Class 2) – even though in the modern systems, Class 1 is commonly shorter than Class 2. Bach's observation has been accepted by most experts on Franconian (e.g. Van Wijk 1935, 1936, 1939; Schmidt 2002; Boersma 2006, forthcoming, Werth 2011; Köhnlein 2011, 2013, 2015). The durational aspects are implemented in the genesis theories of Schmidt (2002) and Boersma (2006, forthcoming), whose tenets I adapt in what follows.[9] It should be noted, however, that the duration-based account is not the only theory of the accent genesis: next to the relatively well-known proposal by Gussenhoven (2000b, 2004, 2013), there is also an approach by Kortlandt (2007).[10] None of these approaches builds on Bach's observation, which means that the distribution has to be explained in different ways; as I discuss in the online appendix, however, both scenarios can only account for a limited set of the facts.

With the durational differences between originally longer Class 1 and originally shorter Class 2 in mind, we can now discuss the basics of the accent genesis and the subsequent durational developments, which ultimately led to the durational reversal in Rule A dialects. The situation in Rule B is somewhat more complex than the one in Rule A, but this is not of immediate relevance for the discussion at hand (but see Köhnlein 2013, 2015 for a detailed treatment). In line with the proposals by Boersma (2006, forthcoming) and Schmidt (2002), I assume that, due to their greater duration, Class 1 units were characterized by larger pitch movements than Class 2 units. Below, I demonstrate this for generally rising contours (LH), in line with what is proposed in Köhnlein (2013, 2015).[11] For the purposes of this paper, however, this choice is largely irrelevant, as the main issue concerns the opposition between contour tones and simplex tones; the proposed mechanisms can be applied in the same way to generally falling contours (HL).

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9. The scenarios are compatible in the sense that they both make use of the insights put forward by Bach. Yet there are some differences between the two theories, which will be briefly discussed subsequently.

10. Ternes (2006) also worked on the history of Franconian, but with a focus on a specific aspect that I will not discuss here in detail, viz. the split between Rule A and Rule B (see §2 for the basic facts).

11. Köhnlein (2013) argues that in the original Franconian system, early vs. late rising contours were the original nuclear pitch accents, and that generally falling tonal contours developed at later stages.

In the predecessor system of Franconian, tonal movements must have started at approximately the same time in Pre-Class 1 and Pre-Class 2 and ended outside of the nuclear accented syllable. Class 1 was longer than Class 2 – therefore, the generally rising contour reached a higher level at the end of bimoraic Pre-Class 1 units than in bimoraic Pre-Class 2 units (this corresponds to Stages 1/2 in Table 1). The difference is schematized in Figure 2: the white box, showing the two accent classes, is wider for longer Pre-Class 1 than for shorter Pre-Class 2, and pitch at the end of the bimoraic unit is higher in Pre-Class 1 than in Pre-Class 2; in both cases, the late low target is a phrase-final boundary tone.

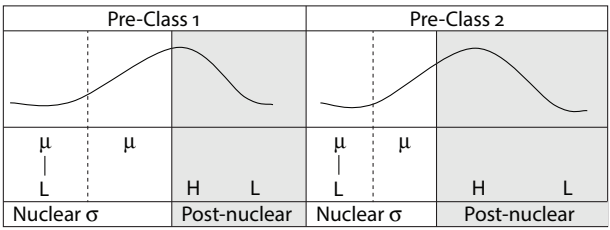

Figure 2. Idealized tonal contours before accent genesis in Franconian

In a second step, the intrinsic pitch differences between Class 1 and Class 2 were reinterpreted as tonal contrast, and the differences between the melodies were extended. The process is indicated in Figure 3: original contours are dashed, novel contours are solid. This led to an early rise for Class 1 (LH in the Class 1 syllable) versus a late rise for Class 2 (L in the Class 2 syllable followed by a post-tonic H); these contours are familiar from modern systems. Crucially, however, since the durational differences were the trigger of the accent genesis, Class 1 must still have been longer than Class 2. This is reflected in Figure 3, where the Class 1 box is wider than the one for Class 2. In the schema given in Table 1, this corresponds to Stage 3.

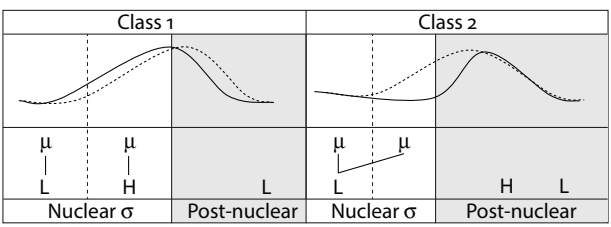

Figure 3. Idealized tonal contours after accent genesis in Franconian

Scholars disagree as to when the contrast became phonologically relevant. The proposal by Schmidt (2002) relies on the idea that schwa apocope is the trigger of

the tonal opposition. Boersma (2006, forthcoming), on the other hand, claims that open-syllable lengthening created the first systematic contrast (lengthened mid and low vowels were shorter than originally long mid and low vowels); other oppositions, such as those caused by apocope, entered the system later. These issues are not of immediate relevance for this paper, as they do not affect the claims about the durational relationship between the tones. Since most tone accent minimal pairs arose through apocope, however, I shall indicate on the basis of the examples in (2) how the original durational differences were reflected in the respective distributional classes.

Let me begin with (2a), the opposition between the nominative and the dative of the word for "house", [haus^{c2}] "house-NOM" vs. [haus^{c1}] "house-DAT". The MHG form of "house" is *hûs* /huːz/. Since the nominative originally had a long high vowel and was monosyllabic, the item now belongs to Class 2 (see Table 2); /z/ was voiceless on the surface due to final devoicing. The dative form, however, originally had schwa as a dative marker, MHG *hûse* /huːzə/. Because of the following voiced intervocalic consonant, the stressed vowel in *hûse* was phonetically longer than the stressed vowel in the nominative, which resulted in a Class 1 membership. The tone accent minimal pair was created when *hûse* underwent schwa apocope (and subsequently final devoicing), which removed all segmental differences between the two items.

The same principle holds for the other examples in (2), all of which became minimal pairs after apocope: [tɔuf^{c1}] "pigeon" (2b) derives from MHG *tûbe*, and the item received a contour tone (Class 1) because it contained a long high vowel followed by a voiced consonant and schwa. [tɔuf^{c2}] "baptism", on the other hand, derives from MHG *toufe*, i.e. from a closing diphthong followed by a voiceless intervocalic consonant – as a consequence, the diphthong was relatively short, which resulted in a level tone (Class 2). The word for "stone", [ʃdaːn^{c1}] (2c), derives from MHG *stein*; the singular was monosyllabic with a closing diphthong, resulting in Class 2. The plural [ʃdaːn^{c1}] originally had a schwa (MHG *steine*), and the diphthong in the open syllable was relatively longer than the one in the closed syllable; this resulted in a Class 1 membership. Lastly, [man^{c1}] "basket" (1d) derives from MHG *mande*, which was probably pronounced as *manne at the time (/d/-deletion after nasals and liquids is a common diachronic change in the dialect area). Following Bach, the /a/ in *manne* must have been phonetically longer than in [man] "man", MHG *man*. Additionally, it may well have been the case that the nasal was also phonetically longer since it was ambisyllabic (and possibly pronounced as a geminate). Once more, the segmental opposition between the items was obliterated by apocope, but the tonal contrast remained.

Let me end this section with a brief remark on how the tonal contrast in Franconian might be represented in the grammar/the lexicon. In the autosegmental

literature on the subject, we find two opposing views. The 'traditional' approach assumes that Class 2 developed a lexical tone (usually realized as H in declaratives and L in interrogatives) while Class 1 is lexically toneless (e.g. Gussenhoven 2000a, 2004; Peters 2006, 2008). The lexical tone affects the alignment of intonational tones, which in turn derives the tonal surface contrast. A more recent alternative is to assume that the two accents differ in their metrical structure, i.e. that they have two types of metrical feet (Kehrein 2007, forthcoming, Hermans 2009, 2012; Köhnlein 2011, forthcoming, Van Oostendorp forthcoming). This 'metrical approach' is also supported by Kingston (2011: 2325–2326), who states that "[i]n the present-day languages, the tones themselves arise from the intonation, and there is no reason to think that they have not done so throughout the period when the accentual contrast developed." Kingston also raises the question whether the developments in Franconian should be treated as an instance of tonogenesis (as no lexical tone arose, but rather a difference in the alignment of intonational tones) – we shall return to this issue in §5.2.

3.2 After the genesis: Tone influences duration

After the original pitch contrast in Franconian was phonologized, Class 1 words had contour tones and Class 2 words had level tones, which was a consequence of the longer original duration of Class 1. Yet we have seen in §2 that in present-day Franconian, Class 1 is SHORTER than Class 2, counter to the reconstruction of the historical facts provided in §3.1. Since bimoraic contour tones prototypically tend to be shorter than level tones (see §2), Franconian must have restored this default relation over time. Thus, units with contour tones (Class 1) became gradually shorter, and units with level tones (Class 2) became gradually longer (Stage 4 in Table 1). In at least most modern systems, this process is completed: reflexes of originally longer Class 1 are now shorter than reflexes of originally shorter Class 2. The system has therefore reached Stage 5 (durational reversal). An idealized version of the durational developments is shown in Figure 4: Class 1 is now shorter (solid line) than it was originally (dashed line), while Class 2 is longer (solid line)

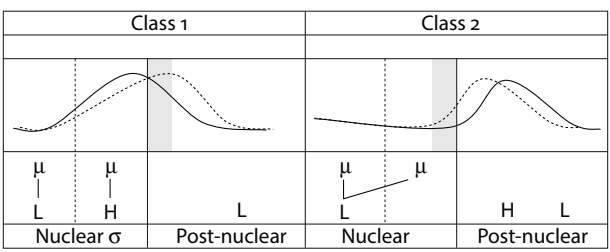

Figure 4. Durational reversal in Franconian

than it was originally (dashed line). A rough indication of the respective shortening/lengthening of the accent classes is indicated with a grey area. With respect to the example in (2), this means for instance that [haus^{c1}] "house.DAT" is now shorter than [haus^{c2}] "house.NOM", although the vowel in the dative (followed by a voiced intervocalic consonant plus schwa) was originally longer than the one in the monosyllabic nominative.

In some Franconian dialects, we find 'extreme' cases of Class 1 shortening/Class 2 lengthening. The most elaborately described example can be found in the dialect of Weert (Heijmans 2003). In Weert, etymologically short, monomoraic Class 2 vowels have been lengthened to bimoraic vowels; see (4a) for examples from Weert in comparison to the neighboring Baexem dialect. At the same time, many originally long/bimoraic Class 1 vowels are now short/monomoraic, such as those in (4b). We know that this accent-governed reversal of vowel length is phonemic in the modern system (and not 'just' a phonetic implementation of the accent contrast) because the earlier tonal opposition in the dialect has collapsed, as evidenced by the phonetic measurements in Heijmans (2003: 13–17).

(4) a. Lengthening of (former) Class 2 vowels

Weert	Baexem	gloss
[bæːrx]	[bærx^{c2}]	"mountain"
[hɑːnt]	[hɑŋc^{c2}]	"hand"
[æːrm]	[ærm^{c2}]	"arm"

b. Shortening of (former) Class 1 vowels

Weert	Baexem	gloss
[knin]	[kniːn^{c1}]	"rabbit.PL"
[mul]	[muːl^{c1}]	"mouth"
[yl]	[yːl^{c1}]	"owl"

Interestingly, some Class 1 vowels escaped vowel shortening, namely, originally long mid and low vowels (5a), as well as historically lengthened mid and low vowels (5b):

(5) a. No shortening of orig. long non-high (former) Class 1 vowels

Weert	Baexem	gloss
[slɔːp]	[slɔːp^{c1}]	"sleep"
[bloːt]	[bloːt^{c1}]	"blood"
[sxœːp]	[ʃœːp^{c1}]	"sheep"

b. No shortening of lengthened non-high (former) Class 1 vowels

Weert	Baexem	gloss
[daːx]	[daːx^{c1}]	"day"
[zɛːx]	[zɛːx^{c1}]	"saw"
[βeːx]	[βeːx^{c1}]	"road.PL"

Heijmans (2003: 30) (in my view, correctly) points out that the non-occurrence of shortening in non-high vowels must be related to their longer intrinsic duration in comparison to high vowels. Yet Heijmans does not connect this property to the distributional patterns at the time of the accent genesis, as given in Table 2. (Recall that originally long mid and low vowels in Franconian always belong to Class 1 in modern dialects.) It is remarkable that in the Weert shortening processes, the group of long non-high vowels was singled out in a similar way as we find it in the original system. At the time of the accent genesis, originally long and lengthened mid/low vowels did not group together, as the lengthened vowels were still shorter than their originally long counterparts. When long vowels were shortened in the Weert dialect, however, the lengthening process must have been (long) completed. Accordingly, there was no reason to treat the two groups differently in the synchronic system.

A comparable process has occurred in Luxembourgish, a language that originally had the Franconian tone accent contrast but lost it over time (see Gilles 2002 and references therein). Gilles (2002: 274–279) shows that in Central Luxembourgish, most originally long monophthongs/diphthongs were shortened if they belonged to Class 1 etymologically; long Class 2 vowels, on the other hand, were not shortened. As in Weert Franconian, Class 1 shortening did not apply to long mid and low vowels (Gilles 2002: 275). Furthermore, while Heijmans' paper only provides examples of vowel shortening in Class 1 for sequences of long vowel + sonorant, Gilles (2002: 275) also gives examples of developments from VVO to VO, such as the change from MHG *bluot* to [blʊt].[12]

Related scenarios have also been attested in other dialects in the area around Weert, as shown in an acoustic study on the development of high vowels in seven (former) tone accent systems by Peeters & Schouten (1989). An interesting case is the dialect of Molenbeersel, where the authors found a length split in high vowels: short [i] and [u] corresponded to Class 1, and [iː] and [uː] corresponded to Class 2. The authors argue that the tonal distinction is gone, and that the original tonal contrast between Class 1 and Class 2 has now turned into an opposition between a phonologically short and a phonologically long vowel. Such examples show that shortening under Class 1 and lengthening under Class 2 can lead not only to (phonetic) DURATIONAL reversals between two bimoraic units. At least in vowels, it can even result in (phonological) LENGTH reversals, with originally

12. The lack of relevant examples in Heijman's paper has been pointed out to me by a reviewer. I do not know whether this absence is accidental or systematic – since the paper does not address the issue explicitly, I tentatively assume that it is accidental.

monomoraic Class 2 vowels becoming bimoraic (MHG *hand* > [haːnt] in Weert) and originally bimoraic Class 1 vowels becoming monomoraic [MHG *iule* /yːlə/ > [yl] in Weert).

With respect to the Weert facts, a reviewer raises the question why tonal neutralization should occur to begin with, given that a change from VVR to VR (e.g. [kniːn^{c1}] to [knin]) could still provide sufficient space to realize a tonal contour; in phonological terms, the lost mora from the vowel could have been re-assigned to the coda consonant, and a bimoraic sonorant domain would still be available. There are two general possibilities to account for this development: first of all, the tonal contrast may have been lost for reasons independent of vowel shortening (whatever these reasons may be), and the quantity splits would be a consequence of regrouping the former tone accent vowels into two length classes, depending on their respective duration. A second option would be to see the loss of the tone accent contrast as a consequence of the durational developments. Along these lines, the durational differences between Class 1 and Class 2 would have been reinterpreted as a short-long contrast for many vowels, which would then have reduced the functional load of the tonal opposition in various corners of the system. Subsequently, the tonal feature would have become (largely) redundant and would eventually have been lost. Such a functional perspective is taken in Cajot (2006). Based on a dialect survey of 42 Franconian dialects in the western border area (South Limburg), Cajot claims that the higher the number of accent-induced phonemic splits between vowels, the likelier it is that the dialect will lose the tonal contrast.[13] It should be noted, however, that Cajot's findings are based on his own auditory interpretation of the data – no systematic perception or production studies have been conducted.

Another reviewer asks why the shortening/lengthening processes in Weert and other dialects seem to affect predominantly vowels, although tone accents are a property of sonorant rhymes (including syllable-final sonorants). This pattern may be comparable to what we find in stress languages like Dutch: as discussed in Van Heuven (2014), lengthening under stress in Dutch is largely restricted to vowels and affects codas to a considerably lesser degree (onsets are essentially irrelevant). Along these lines, shortening under Class 1/lengthening under Class 2 may also in the first place affect vowels (recall that the accents are restricted to

13. The notion 'phonemic split', however, refers not only to alternations in quantity but also to segmental splits between Class 1 and Class 2, which can be found in various dialects. For instance, Class 1 vowels tend to diphthongize to closing diphthongs across dialects, and Class 2 vowels tend to monophthongize (see Köhnlein forthcoming for a synchronic analysis of the patterns).

stressed syllables). I am not aware, however, of any studies on Franconian that systematically investigate the duration of specific segments in the syllable rhyme as a function of the accent class.

To conclude the Franconian part of this paper, let me briefly summarize the main points of the discussion so far. It has been argued that a tonal contrast on stressed vowels can reverse its durational correlates over time. At the time of the accent genesis in Franconian, Class 1 developed tonal contours because pre-Class 1 vowels were intrinsically longer and could support stronger pitch movements than pre-Class 2 vowels; yet under the influence of the fully shaped tonal contours, Class 1 vowels became shorter over time than Class 2 vowels. This was the result of phonetic shortening under contour tone (Class 1) versus phonetic lengthening under level tone (Class 2). In extreme cases, this even led to phonological shortening of originally long vowels in Class 1 and to phonological lengthening of originally short vowels in Class 2. As a consequence, the synchronic systems of Franconian that have been described so far have usually reached Stage 5 on the scale proposed in Table 1, i.e. the durational relation between Class 1 and Class 2 has been reversed.

This raises the question whether it is possible to determine at which point of the development the durational reversal is triggered. As was briefly suggested in the introduction, the crucial turning point in the diachronic relationship between duration and pitch/tone is reached when a duration-based intrinsic pitch contrast is exploited by the phonology, i.e. when the gradual phenomenon 'longer duration' → 'stronger pitch movement' turns into a tonal surface contrast. Before a phonetic pitch contrast becomes categorical, strong versus less strong pitch movements in accented syllables are part of the realization of a non-distinctive intonational (falling or rising) pitch accent, depending on the duration of the units on which it is realized. When, however, such an originally redundant pitch contrast becomes categorical, it will be part of the phonological knowledge of the speaker. It is reasonable to assume that, after being 'promoted' to a phonological contrast, the realization of the newly developed tonal melodies is not an epiphenomenon of fine-grained durational differences anymore. Instead, the tones can develop 'their own' phonetic implementation, i.e. they can influence other parameters, such as their duration. Consequently, it is now not pitch anymore that is DEPENDENT on duration; instead, tone INFLUENCES duration. If, then, bimoraic sonorant units are, as a default, relatively short under contour tone and relatively long under level tone, the situation after the genesis of the tonal contrast (contour tone longer, level tone shorter) is typologically unusual – in response to this, there can be a tendency for tonal contours to shorten over time, and for level tones to lengthen (as we can observe in Franconian).

Assuming that the proposed analysis of Franconian is correct, one might expect that there could be prosodic systems that display similar tendencies but

have not reached the late stages of this development. Some relevant cases are discussed in the following section.

4. Tone-duration interactions outside of Franconian

In this section, I first address two systems with ternary durational contrasts on the surface (Estonian and North Low Saxon), which include an opposition between long and overlong vowels. For both systems it has been reported that the quantity contrast can be enhanced by a tonal opposition. §4.1 discusses the well-documented case of Estonian, and §4.2 the less clear-cut situation in North Low Saxon. §4.3 presents additional evidence in favor of the duration-based genesis of tonal contrasts from Las Norias Piman and Hup (examples from Hyman 2012).

4.1 Estonian

Estonian displays a ternary durational contrast in stressed syllables, commonly referred to as Q1 (short), Q2 (long) and Q3 (overlong).[14] The opposition can either be based on three degrees of vowel duration or on three degrees of consonant duration. Two classic triplets for each of the patterns are presented in (6):

(6) a. [sada] "hundred" [saːda] "send-IMP" [saːːda] "to receive"
b. [lina] "flax" [linːa] "town-SG.GEN" [linːːa] "town-SG.PART"

Lehiste (1960) was the first to suggest that (modern) Estonian expresses the opposition between Q2 and Q3 not only by means of syllable duration but also via F0: Q3 is characterized by a falling tone in the stressed syllable, while Q2 has a high level tone and a post-tonic fall. The existence of the tonal contrast has since then been confirmed in various production studies (Liiv 1961; Remmel 1975; Asu et al. 2009; Plüschke 2013, among others; see Plüschke 2013 for a concise summary of previous research), and its perceptual relevance for the distinction between Q2 and Q3 has been proven experimentally (Lehiste & Danforth 1977; Eek 1980; Lehiste 2003; Lippus et al. 2009, 2011).

To understand why the Estonian facts are of particular relevance for the discussion, consider another important observation by Lehiste: reviewing the evidence collected over several decades by her and others, Lehiste (2003: 64) argues that Estonian "has changed from a quantity language to an accent language". That

14. Etymologically, Q3 syllables derive from disyllabic units whose second syllables were deleted. Q2 syllables correspond to monosyllabic units historically (Lehiste 2003 for summary).

is, she claims that the durational cue for the distinction between Q2 and Q3 has lost strength over time while the pitch cue has strengthened. According to Lehiste, the durational contrast still serves to distinguish the word groups, but only in combination with the tonal differences.

This change in Estonian can easily be incorporated into the model of the interaction between tone/pitch and duration presented in this paper: let us assume that, before pitch played a distinctive role in the system, Estonian predominantly had a durational contrast between Q1, Q2 and Q3. This corresponds to Stage 1 in Table 1. Similar to Franconian, we can assume that tonal movements (here: a pitch fall) started at approximately the same time and reached a lower level at the end of (longer) Q3 syllables than at the end of (shorter) Q2 syllables. Over time, this led to a tonal reinterpretation of the contrast, resulting in a fall for Q3 (HL) versus a high level tone (H) for Q2, corresponding to Stage 3 in Table 1 – a scenario that is perfectly compatible with the reconstruction provided in Lehiste (1978). The process is visualized in Figure 5; again, dashed lines represent the original stage, and solid lines stand for the system with the newly emerged tonal contrast.

Note that I give both syllables as bimoraic, in spite of the longer duration of Q3 in comparison to Q2. This representation is based on a metrical analysis of the opposition in Prince (1980). Essentially, Prince (1980) argues that the contrast between Q2 and Q3 is one of foot structure rather than one of phonemic length (somewhat similar to the metrical approach to Franconian briefly discussed in §3.2): Q3 is a monosyllabic foot, and Q2 is a disyllabic foot. The distinction long vs. overlong is the phonetic implementation of foot structure: in Q3, the duration of a foot is expressed in one syllable; in Q2, the duration of a foot in divided over two syllables. The analysis is based on various types of evidence, ranging from the distribution of secondary stresses to effects of consonant gradation (see Prince 1980 for further discussion). Odden (1997) has translated this representation into a moraic model, with both Q2 and Q3 being phonologically bimoraic. In Köhnlein (manuscript), I argue that the tonal differences can be attributed to the mapping of a foot-final low boundary tone (L%): Both Q2 and Q3 have a high prominence

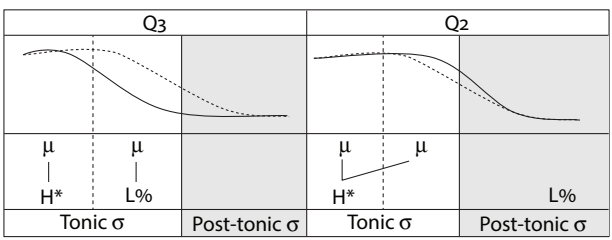

Figure 5. Durational and tonal contrasts in Estonian

tone; in Q3, L% associates with the second mora of the stressed syllable, since this is also the right edge of the monosyllabic foot – this derives the falling contour (HL). In Q2, the right edge of the (disyllabic) foot is in the post-tonic syllable, and L% associates with the mora in the second syllable – hence the relatively late pitch fall. Note that with respect to the interaction of tone and duration discussed in this paper, this representational decision is not crucial. That is, the relevant diachronic principles could for instance also be expressed with a phonemic distinction between bimoraic and trimoraic syllables (along the lines of Hayes 1995), albeit possibly in a less straightforward way (see Köhnlein manuscript for further discussion).

Lehiste's claim that the primary contrast in quantity is replaced by an opposition where tone/pitch is primary has recently been confirmed in a diachronic phonetic study by Lippus & Ross (2011). The authors compare the realizations of speakers from different dialect regions at two points in time: one group consists of speakers recorded between 1916 and 1918, the other group of present day speakers from the same regions. They find that the durational differences between Q2 and Q3 have become smaller, while at the same time, the pitch cue has become more prominent (Lippus & Ross 2011: 1265). A similar pattern has also been described for Leivu Estonian, a variety of Estonian spoken in Latvia: as shown by Teras (2010), Q3 still tends to be longer than Q2, but there is a considerable overlap in syllable durations. More consistently than through duration, however, Q2 and Q3 are distinguished via their tonal contours, usually an early peak and a subsequent fall in Q3 versus a late peak for Q2.

The Estonian facts are perfectly in line with what has been argued for Franconian: the emergence of a tonal opposition can be a prerequisite for a subsequent shortening of the longer unit (due to the influence of the bimoraic contour tone) and/or for lengthening of the shorter unit (due to the influence of the bimoraic level tone). In terms of the stages outlined in Table 1, we can therefore assume that Estonian has developed from a Stage 1 system to a Stage 4 system.

4.2 North Low Saxon

North Low Saxon, spoken in northern Germany, has a ternary durational contrast between short, long and overlong vowels. Historically, overlong vowels derive from schwa apocope, which led to compensatory lengthening of the preceding vowel iff the intervocalic consonant was voiced (similar to the development of most tonal minimal pairs in Franconian). The opposition is not always 'perfect', however: unlike in Estonian, it usually correlates with a contrast in vowel quality: short vowels are always lax while long/overlong vowels are usually tense

(Kohler 2001; Prehn 2012).[15] An example of the contrast is given in (7); data are from Prehn (2012):

(7) [zɪt] "sit.1SG.PRES" [riːs] "rice" [riːːz̥] "giant"

While the existence of a phonetic opposition between three degrees of quantity is unquestioned, there is a long-standing debate as to whether pitch can also play a role in the discrimination between long and overlong vowels. So far, there have been no detailed phonetic studies that would confirm such a correlation; in fact, the few available acoustic studies do not show reliable F0 differences between long and overlong vowels across speakers (see Kohler 2001; Prehn 2012). Still, it has repeatedly been claimed in the literature that in some dialects, a tonal contrast accompanies the ternary quantity contrast (e.g. Bremer 1929; Feyer 1941; Niekerken 1954; Hildebrandt 1963; Ternes 1981, 2006; Höder 2010, 2014; see Prehn 2012 for a detailed summary of previous literature); yet the (largely impressionistic) descriptions of the precise phonetic characteristics of the tonal contrast vary.

There are two cases, however, where acoustic measurements seem to indicate a tonal contrast. Ruscher (1983: 43) shows spectrographic measurements for one minimal pair, [ziːt] "since" versus [ziːːt] "silk". Ruscher's data show a high level tone for the long vowel, and a falling tone for the overlong vowel (the fall occurs in the second part of the vowel). Ruscher, who argues that there is a tonal opposition in Heikendorf, also notes that the tonal feature seems to be present only in some dialects. Moreover, Prehn (2012: 87) observes that in non-final position of declarative phrases, one of her informants consistently produced long vowels with high level tone and overlong vowels with falling tone (in final position, the contrast is smaller, but overlong vowels are produced with a steeper fall than long vowels).

If, with the limitations of the available evidence in mind, we relate these findings to the developmental stages proposed in Table 1, we can conclude that some North Low Saxon varieties might have reached either Stage 2 (pitch contrast) or even Stage 3 (tonal contrast). Clearly, however, additional research is needed to assess the situation in more detail. If such studies should confirm tonal differences between long vowels with high level tone and overlong vowels with falling tone in some dialects, we might expect the durational opposition in these varieties to be smaller than in dialects with a purely durational contrast. This would correspond to the attested diachronic development in Estonian, and also to the reconstructed durational reversal postulated for Franconian.

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15. Some dialects, however, also allow for (a limited set of) long and overlong lax vowels (see Höder 2014).

4.3 Las Norias Piman and Hup

Two more cases where durational differences led to the introduction of a tonal contrast between level and contour tones can be found in Las Norias Piman (Uto-Aztecan) and Hup (Nadahup; both sets of examples are taken from Hyman 2012). In Las Norias Piman, which is also known as Sonoran O'odham, a contrast in coda voicing has been replaced by a tonal contrast (according to Shaul 2006): vowels followed by originally voiceless obstruents have received a high level tone; vowels followed by originally voiced obstruents have a falling tone (8). The closely related Tohono O'odham forms suggest that the proto-language had a voicing contrast (Hyman 2012):

(8)

	"stomach"	"road"
Tohono O'odham	vo:k	vo:g
Las Norias Piman	vo:^{H}k	vo:^{HL}k

As Hyman suggests, durational differences between the two groups of vowels (cross-linguistically, vowels are often longer before voiced obstruents) might be responsible for the distribution of tone: the originally longer unit received a contour tone, the shorter unit a level tone. The parallels to the Franconian situation, as described in §3, are obvious. Since Las Norias Piman has (root-initial) stress (Jacob Franco Hernández p.c.), we might add that the depicted interactions occurred in stressed syllables – another similarity to Franconian, Estonian and North Low Saxon. It should, however, be noted that Shaul's paper provides preliminary findings on the basis of work with one native speaker.

Hyman also discusses an example from Hup (Epps 2008), where voicing in coda obstruents affects the duration of preceding high-toned vowels in a way that the longer vowel can host a falling tone: the language has an allophonic contrast between high tone (H) and falling tone (HL) on stressed vowels. When a stressed syllable ends in a voiceless obstruent, we find high tone (9a); when it ends in a voiced obstruent, the syllable has falling tone (9b).[16]

(9) a. [ču^{H}k] "tool handle"
b. [ču^{HL}g] "hummingbird"

5. Possible phonetic motivations and implications for prosodic typology

The preceding sections have demonstrated that languages can have an ambivalent relationship between pitch/tone and duration on bimoraic sonorant units. The

16. Note, however, that we cannot refer to these domains as bimoraic sonorant units, since the vowels are phonologically short; still, the data clearly suggest a relationship between duration and tone.

evidence presented in this paper indicates that contour tones can appear on longer units as a result of a duration-based genesis of tone; yet, ceteris paribus, they tend to be shorter than level tones synchronically, which suggests durational reversals over time. This raises three interrelated questions that will be discussed in this section. Question (10a) and (10b) will be treated in §5.1; (10c) will be discussed in §5.2.

(10) Some remaining issues
   a. Phonetic motivation I: Are there specific types of languages where durational differences can lead to tonal contrasts?
   b. Phonetic motivation II: All else being equal, why should contour tones on bimoraic sonorant units be relatively short, and level tones relatively long?
   c. Typological implications: What do these interactions tell us about the typology of prosodic systems?

5.1 Possible phonetic motivations

With regard to (10a), it has been argued in §§2–4 that longer duration comes with the possibility of hosting stronger pitch movements, which can eventually lead to a tonal opposition between a contour tone and a level tone. Notably, in all cases discussed in this paper, the tonal contrasts arose in STRESSED syllables. This suggests that the duration-based genesis of tonal contrasts could be a property of stress systems. This would not be too surprising since, from a general perspective, both longer duration as well as enhanced durational contrasts are typical correlates of stressed syllables in many languages.

That is, phonological/phonetic contrasts tend to be more pronounced in stressed syllables than in unstressed syllables (e.g. Lindblom 1990; De Jong 1995, 2004). Therefore, we might expect intrinsic factors influencing vowel duration (such as vowel height, obstruent voicing) to be more prominent under stress. This in turn would make it more likely for redundant pitch contrasts to become exaggerated and ultimately be phonologized. To illustrate the general idea, let me give two examples from non-tonal stress languages.

An example of a stress-based interaction between vowel height and vowel duration can be found in Dutch (Rietveld et al. 2004: 359): the tense low vowel /a/ is considerably longer in syllables with primary stress, where it is on average 199 ms long, in comparison to 65 ms in post-tonic position. The tense high vowel /i/, on the other hand, lengthens only minimally under stress: main-stressed /i/ is on average 83 ms long, post-tonic /i/ 68 ms. As we can see, there is a substantial durational difference between /a/ and /i/ under stress (199 ms to 83 ms) but no such difference in unstressed syllables (65 ms vs. 68 ms). While it seems obvious that the durational contrast has its origin in the intrinsically longer duration of /a/, the effect is restricted to stressed syllables.

As a second example, consider the effects of obstruent voicing on the duration of preceding vowels in English. As shown in an elaborate acoustic study by De Jong (2004), vowels are longer when they precede a voiced coda obstruent than when they precede a voiceless coda obstruent, but only when these vowels occur in stressed syllables – in unstressed syllables, the effect disappears. Interestingly, the durational contrast is strongest in syllables carrying a nuclear pitch accent, i.e. syllables with intonational prominence at the phrase level. This suggests that phrasal stress, or maybe even the presence of intonational pitch accents as such, further boosts the effect.

In sum, the interaction 'longer duration' → 'stronger pitch movements' → 'stronger likelihood to develop a contour tone' appears to be a prototypical property of stressed syllables, which in turn might limit the genesis of duration-based tonal contrasts to systems with word stress.

Let us now turn to (10b). Why should, all else being equal, contour tones on bimoraic sonorant units be shorter than level tones? Boersma (forthcoming), who discusses the durational reversal in Franconian, argues that "movement (e.g. pitch movement) can be perceived even if it is fast, whereas detecting constancy (e.g. monotonicity) takes a while".[17] He assumes this to be the cause of the relative shortness of units with contour tones. Boersma's perception-based explanation does not explicitly address the widely attested pattern that, for articulatory reasons, tonal contours need a sufficient amount of time to be realized (see §1). If we take this aspect into account as well, we could say that tonal contours are avoided on phonetically short units due to articulatory reasons, which is a production-based restriction. On phonetically longer units with enough phonetic space to realize a pitch movement, the perception-based constraints suggested by Boersma would come in. The reason that the 'perfect' duration for a contour tone is somewhere between 'really short' and 'really long' would then be found in different types of constraints on monomoraic units (articulatory factors) and bimoraic units (perceptual factors).

An alternative possibility could be to argue that BOTH interactions are based on articulatory constraints: on the one hand, we know that speakers need sufficient time to realize a tonal contour. Yet when the available space increases continuously, for instance when a vowel becomes longer and longer, there may well be a point where it becomes more DIFFICULT to produce a continuous F0 movement/a tonal contour throughout the vowel than to produce level F0/a level tone. This

17. An anonymous reviewer has asked whether there are perception experiments indicating that listeners perceive pitch movements faster than steady pitch. I am not aware that such studies exist.

could be due to an additional articulatory limit, viz. the maximum/minimum F0 that a speaker can (comfortably) produce. That is, producing a continuous pitch movement is only possible to the point when a speaker reaches their F0 maximum/minimum. This type of constraint does not apply to the production of level tones, where speakers will normally not reach this point. Possibly, this articulatory constraint on the production of pitch movements might even be related to the fact that chanted calls, which are often characterized by a relatively long duration, are commonly produced with level pitch at different heights, rather than with rising/falling pitch movements (Liberman 1975; Hayes & Lahiri 1992; Gussenhoven 1993).

At this point, however, such explanations have to remain speculative – clearly, these issues require future research.

5.2 Possible typological implications

As argued in §5.1, the duration-based genesis of tonal contrasts between contour tones and level tones appears to be a prototypical property of stress systems, which would imply that we should not find such developments in languages without word stress. Assuming that future studies will confirm these patterns, this finding adds to our knowledge about the diachronic typology of prosodic systems. While, as we have seen above, the general idea that durational differences can facilitate the genesis of tonal contrasts is not new (it can be found in the literature on Franconian or the cases discussed in Hyman 2012), explicitly linking this behavior to systems with word stress is a novel proposal. Furthermore, given that the default relationship between contour tones and level tones on bimoraic sonorant units indeed follows from general perception/production tendencies that hold across languages, this constitutes an insight into general phonetic characteristics of tone that has not been widely acknowledged so far.

Taken together, these two patterns also seem to predict that diachronic shortening/lengthening processes of the type that we find in Franconian (in an extreme way) and Estonian (in – at least so far – a less extreme way) should be properties of languages with word stress that have undergone a duration-based genesis of a tonal contrast – after all, only in such languages we would expect to find significantly longer contour tones than level tones to begin with. It is tempting to ask whether such patterns could contribute to ongoing debates on the SYNCHRONIC typology of prosodic systems, particularly concerning the typological status of tone accent systems.

Let me very briefly introduce the fundamental aspects of an ongoing controversy on the subject on the basis of work by Larry Hyman and Harry van der Hulst. Hyman (2006, 2009, 2011) has repeatedly claimed that the notion of 'pitch

accent' (and thereby also tone accent) is a typologically problematic category, which should not be used as a prototype in typological discussions. For instance, he argues that it is not possible to find a consistent set of properties that reliably characterizes alleged pitch accent systems, i.e. properties that cannot be found in more prototypical tone systems or stress systems. Under his view, tone accent systems like Franconian combine properties of stress and tone but do not constitute a typological prototype. Van der Hulst (2011, 2012), on the other hand, claims that pitch accent should be regarded as an independent typological category, since properties of pitch accent are different from many properties of word stress (such as rhythm and weight) as well as from properties of lexical tone. Essentially, he claims that grid marks/asterisks are phonological objects that mark the location of accentual prominence in a word. In systems where accentual prominence is consistently realized as (high) pitch, he speaks of 'pitch accent languages'. Languages in which the main correlates of word accent do not involve pitch are referred to as 'stress accent languages', an example being English (e.g. Van der Hulst 2011: 1508–1510).

Do the diachronic processes discussed in this paper support one of these two positions? That is, are the described patterns properties of systems that combine elements from stress and tone but that cannot be regarded as prototypical in a specific way (which would fit in Hyman's typology)? Or should they be regarded as a property of a specific type of prosodic systems (such as pitch accent/tone accent systems), which would appear to be closer to Van der Hulst's position in the debate (without necessarily committing to the details of the corresponding representational approach)?[18]

At a descriptive level, we could say that a language with a duration-based genesis of a tonal contrast goes, broadly speaking, from, [+stress] and [−tone] to [+stress] and [+tone], which should be perfectly in line with Hyman's typological approach. The crucial question, however, would be whether the nature of this development can predict anything about the synchronic phonological status of [+tone]. For instance, we could wonder whether such a development might predict that speakers are likely to analyze the emerging tones as intonational; these tones would then associate to two groups of words in different ways, depending on the metrical structure of the items in question. In this context, recall the quote from Kingston (2011: 2325–2326) provided in §3.1, which states that, at least in

18. In fact, there is an increasing amount of scholarly work where tone accent systems are analyzed in terms of contrastive foot structure, rather than with grid marks or based on an interaction between stress and lexical tone. In this paper, I have briefly sketched such approaches for Franconian (§3.1) and Estonian (§4.1). Similar analyses of tone accent oppositions have been proposed for, e.g. Scandinavian (Morén 2005, 2007, Morén-Duolljá 2013), Scottish Gaelic (Iosad 2015) and Ancient Greek (Kager & Martínez-Paricio 2014).

Franconian, it seems likely to assume that the tone accent contrast has always arisen from intonation, in the early stages as well as in the present-day opposition. Of course, we cannot postulate that a duration-based genesis of tone will imply a synchronic metrical representation, for the obvious reason that speakers of later generations will have no knowledge about the diachronic origins of tone. One may wonder, however, whether, e.g. the correlates that played a role during the origin of the tonal contrast in Franconian (duration, intonational tone, vowel quality, consonant voicing), all of which are common correlates of word stress, could not somehow survive in the present day system in a different but related way. This could then lead to the specific phonetic/phonological characteristics that differentiate tone accent systems such as Franconian from languages that have tone in the lexicon.

While, at this point, it seems difficult to provide reliable answers to these questions, the patterns discussed in this paper make it possible to identify specific questions that should be addressed in future research: next to diachronic and synchronic studies on different types of prosodic systems, this should include systematic comparisons of the duration of level tones and contour tones across tone systems, intonational/stress systems and tone accent/pitch accent systems (here, I use these 'prototypes' as purely descriptive notions), as well as perception tests on perceived duration with speakers from different languages.[19] To give but one example, one may wonder whether e.g. speakers of Estonian, where contour tones on bimoraic units are longer than level tones, perceive level pitch/dynamic pitch differently from speakers of Franconian, where level tones are longer than contour tones. Such cross-linguistic comparisons will illuminate to what degree different types of interactions between tone and duration are universal, determined by different types of prosodic systems or language-specific.

6. Summary and conclusion

This paper served to show that there is an asymmetry in the interaction of pitch/tone and duration in tone accent systems: in fully developed tonal oppositions on bimoraic sonorant syllable rhymes, units with a contour tone (HL, LH) tend to

19. It should be noted, however, that with respect to perception tests, a first cross-linguistic study has been conducted by Lehnert-LeHouillier (2007), who found lengthening effects for Japanese listeners, but not for German, Thai and Spanish listeners. According to Cumming (2011:376), however, it is possible that the structure of the stimuli influenced the outcomes. Thus, more experiments are needed to shed light on these fundamental questions about the relation between tone/pitch and length/duration.

be shorter than units with a level tone (H, L), ceteris paribus. Yet the relationship can be different in systems where tonal contrasts are based on original durational differences between two groups of bimoraic units: in such systems, tonal contrasts can arise as a consequence of the fact that phonetically longer units can host stronger pitch movements than shorter units. After such a pitch contrast has been phonologized (and is phonetically extended), there is a tendency to shorten the unit with the contour tone and to lengthen the unit with the level tone. It has been argued that in Franconian, this has led to durational reversals between two word classes, where the originally longer class, Class 1, is now shorter than its originally shorter counterpart, Class 2. Earlier stages of this development have been claimed to exist in Estonian, (possibly) North Low Saxon, Las Norias Piman and Hup. Furthermore, I have discussed possible phonetic motivations for the observed patterns, and to what degree they might contribute to key aspects in the ongoing discussion on the typology of prosodic systems.

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Appendix

http://www.dx.doi.org/10.1075/dia.32.2.03koh.additional

Résumé

La réalisation d'un ton à contour exige une plus longue durée que la réalisation d'un ton ponctuel. Cet article montre que cette relation temporelle devient considérablement plus compliquée si les tons sont réalisés sur des sonorantes bimoraïques, qui peuvent porter aussi bien des tons ponctuels que des tons à contour. Les

preuves présentées proviennent d'un certain nombre de processus diachroniques dans lesquels hauteur et durée interagissent. Dans les langues où les différences temporelles (intrinsèques) entre deux groupes d'unités bimoraïques entraînent des différences tonales, les unités plus longues obtiennent généralement un ton à contour, et les unités plus courtes un ton ponctuel. Néanmoins, au cours du temps, les unités avec un vrai ton à contour tendent à devenir plus courtes, tandis que les unités avec le ton moyen tendent à s'allonger. Ces développements pourraient, en fin de compte, entraîner un renversement temporel entre les unités en question. La discussion porte surtout sur l'accent tonal franconien, mais elle tient également compte de données d'autres langues : estonien, hup, piman de las norias et bas saxon septentrional.

Zusammenfassung

Die Produktion eines Konturtons erfordert eine längere Dauer als die Produktion eines Leveltons. Dieser Artikel zeigt, dass die Beziehung zwischen Dauer und Ton deutlich komplizierter wird, wenn Töne auf sonoranten, bimoraischen Einheiten realisiert werden, die sowohl für Leveltöne als auch für Konturtöne lang genug sind. Die Evidenz hierfür kommt aus diachronen Veränderungen, bei denen Ton und Dauer interagieren: In Sprachen, in denen intrinsische Dauerunterschiede zwischen zwei bimoraischen Einheiten zu tonalen Kontrasten führen, erhalten die längeren Einheiten im Allgemeinen einen Konturton und die kürzeren einen Levelton. Im Laufe der Zeit können die Einheiten mit Levelton jedoch kürzer werden, und jene mit Konturton länger, was sogar zu umgedrehten Dauerverhältnissen zwischen den Einheiten führen kann. Die Rheinische Akzentuierung steht im Zentrum der Diskussion, aber es werden auch Daten aus, unter anderem, dem Estnischen, Hup, Las Norias Piman und dem Nordniedersächsischen miteinbezogen.

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