The Phonetic Basis for Tonal Melody Mapping

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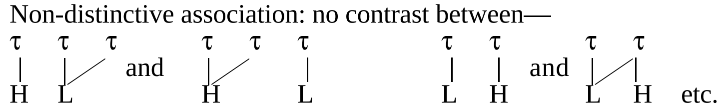
1. Introduction—Two Types of Tone Languages

The basic tenet of autosegmental phonology is that phonological representations are tiered. An autosegmental representation of tone assumes that tones and tone-bearing units (TBUs) occupy different tiers in the phonological representation and are linked together either underlyingly or during the derivation from the input to the output (Leben 1971, 1973, 1978, Goldsmith 1976, Clements and Ford 1979, Halle and Vergnaud 1982, Pulleyblank 1986, *inter alia*).

If we subscribe to the view that tones are autosegmental, we can in principle distinguish two types of tone languages. The first type is languages in which the association between tones and TBUs is non-distinctive. Assuming the Obligatory Contour Principle (OCP) in the lexicon (Odden 1986), this means that for a set number of TBUs and a specific tonal melody, there is a unique way in which these elements on the two tiers are associated. Consequently, there is no contrast between trisyllabic High-Low-Low and High-High-Low, or disyllabic Low-High and Low-Rise, etc., as shown in (1) (τ=TBU).

(1) Non-distinctive association: no contrast between—



From a derivational point of view, this tonal pattern can be construed as follows: tones and TBUs are unassociated underlying; during the derivation, tones are linked to TBUs according to the *Association Conventions* and *Well-formedness Condition* envisioned by Leben, Goldsmith, Pulleyblank, and others.

(2) a. *Association Conventions*:
Map a sequence of tones onto a sequence of tone-bearing units,
(a) from left to right;
(b) in a one-to-one relation.
b. *Well-formedness Condition*:
Association lines do not cross. (Pulleyblank 1986: p. 11)

From an Optimality-Theoretic perspective, we may entertain the following constraints in (3) (after McCarthy and Prince 1993, 1995).

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(3) a. MAX(TONE): if T is a tone in the input, then T has an identical correspondent in the output.
b. IDENT(TONE): if α is a TBU in the input and β is a correspondent of α in the output, then the tonal specification of α must be identical to the tonal specification of β.
c. Tonal markedness constraints on tonal shape, melody, and association; e.g.,
*T_1T_2: no two tones can be mapped onto a single TBU.
*$T_1T_2T_3$-WORD: no tonal melody $T_1T_2T_3$ can surface on a word.
ALIGN(T, L, W, L): align the left edge of a tone with the left edge of a word.

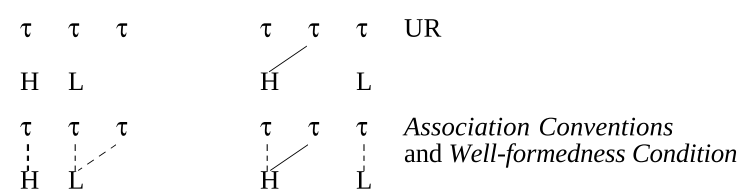
The lack of distinctive tonal association can be accounted for by ranking MAX(TONE) and tonal markedness constraints over IDENT(TONE). Moreover, to ensure that not all conceivable tones in the *Rich Base* (Prince and Smolensky 1993, Smolensky 1996) are realized on the surface, MAX(TONE) must still be outranked by some tonal markedness constraints. This general scheme of constraint ranking is summarized in (4).

(4) Constraint ranking for non-distinctive tonal association:

Some tonal markedness constraints
⇓
MAX(TONE)
⇓
Some other tonal markedness constraints
⇓
IDENT(TONE)

The second type of languages are those in which the association between tones and TBUs *is* distinctive. Obviously, this means that for a set number of TBUs and a specific tonal melody, there is more than one way in which these elements on the two tiers can be associated. The association thus serves a contrastive function in these languages, and consequently, contrasts between trisyllabic High-Low-Low and High-High-Low, or disyllabic Low-High and Low-Rise, for example, are attested.

From a derivational perspective, this tonal pattern can be construed as the presence of prelinking in the underlying representation, and then the execution of the *Association Conventions*, abiding by the *Well-formedness Condition*. The derivation in (5) exemplifies how the contrast between trisyllabic HLL and HHL is rendered in this type of language.

(5)


τ τ τ τ τ τ SR
H L H L

From an OT perspective, the analysis necessarily involves the promotion of the IDENT(TONE) constraint over some tonal markedness constraints, notably constraints on tonal association like ALIGN-L. The tonal association in the underlying representation must then be preserved sometimes, giving rise to the contrastiveness of the association. The general scheme of constraint ranking is given in (6). 'Some other tonal markedness constraints' here necessarily include constraints on tonal association such as ALIGN-L.

(6) Constraint ranking for distinctive tonal association:

Some tonal markedness constraints
⇓
MAX(TONE), IDENT(TONE)
⇓
Some other tonal markedness constraints

In a cross-linguistic survey of positional restrictions on contour tones, Zhang (in preparation) shows that in both types of languages described above, contour tones are more likely to occur on the final syllable of a prosodic domain and syllables in shorter words. Zhang argues that these patterns are phonetically natural, since contour tones require an ample duration to be fully articulated and saliently perceived, and the final syllable in a prosodic domain and syllables in shorter words have a longer duration than nonfinal syllables and syllables in longer words respectively (Oller 1973, Klatt 1975; Lehiste 1972, Klatt 1973, Lindblom and Rapp 1973).

The goal of this paper is to show that for both types of languages, we need to specifically refer to the position of the syllable in the prosodic domain and the syllable count in the word in phonological analyses, in the form of *CONTOUR_i-σ_{nonfinal} and *CONTOUR_i-$\sigma_{\text{short-word}}$, with the implication that speakers are aware of the durational advantage these factors may induce. Using tonal melodies, alignment constraints, and general tonal markedness constraints such as *CONTOUR alone cannot capture all the desired effects of contour restrictions. I will start the discussion from languages with non-distinctive tonal association.

2. Non-Distinctive Tonal Association—Pseudo-Kukuya

2.1. Pseudo-Kukuya

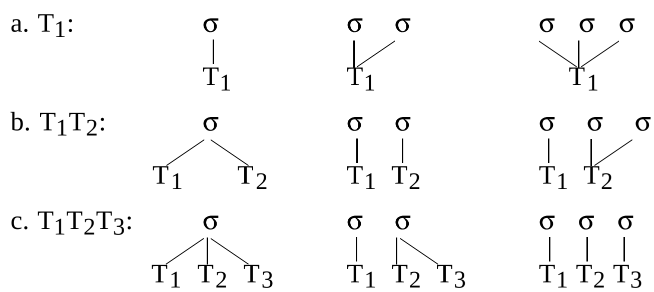
Paulian (1974) claims that there are five tonal melodies in Kukuya: L, H, LH, HL, and LHL. These melodies are mapped onto words of various lengths (from one to three syllables, as given in Paulian 1974). Examples of Kukuya are given in (7).

(7) Kukuya examples:

	σ	σσ	σσσ
H	bá ‘oil palms’	bágá ‘show knives’	bálágá ‘fence’
L	bà ‘grasshopper killer’	bàlà ‘to build’	bàlàgà ‘to change route’
HL	kâ ‘to pick’	kálà ‘paralytic’	kálàgà ‘to be entangled’
LH	sǎ ‘weaving knot’	sàmí ‘conversation’	**mʷàrə̀gí** ‘younger brother’
LHL	bvi᷈ ‘he falls’	pàlî ‘he goes out’	kàlə́gì ‘he turns around’

Apparently, in Kukuya, the mapping of tones to syllables conforms to the *Association Conventions* and *Well-formedness Condition* except for the pattern in bold in the table, which seems to require a right-to-left mapping. But the generalization regarding contour tone distribution holds true for both the general and the exceptional cases: the complex contour LHL and the rising contour LH can only occur on monosyllabic words; and the falling contour HL can only occur on monosyllabic words or the final syllable of disyllabic words. Hyman (1987) and Zoll (1996) have provided two different analyses for the exceptional pattern, neither of which bears on the issue of contour tones. Thus, for reasons of simplicity, I consider in the following analysis Pseudo-Kukuya, which has an exceptionless mapping of one, two, or three tones onto mono-, di-, or trisyllabic words according to the *Association Conventions* and *Well-formedness Condition*. The tonal melodies abide by the OCP. Therefore, T_1=H or L, T_1T_2=HL or LH, $T_1T_2T_3$=HLH or LHL. The tonal patterns of Pseudo-Kukuya are summarized in (8).

(8)



2.2. First Try: ALIGN-L and ALIGN-R

Let us first see whether the gravitation of contours to the final syllable can be achieved without referring to the final syllable as a privileged contour bearer. If the answer is ‘yes’, the phonology that emerges is a traditional one, in the sense that it is autonomous, since the phonological pattern here, even though phonetically natural, is captured without referring to phonetic properties. An obvious route to take is to use an ALIGN-R constraint, as defined in (9). This is a gradient constraint: if the right edge of a tone is separated from the right edge of the word by *n* syllables, the constraint accumulates *n* violations. Its effect can be seen in the tableau in (10). The winner, which has a contour on the final syllable, satisfies ALIGN-R better than the losing candidate, which has a contour on the initial syllable.

(9) ALIGN (T, R, W, R) (abbr. ALIGN-R):
The right edge of a tone must align with the right edge of a word.

(10)

	σ σ T_1 T_2 T_3	ALIGN-R
☞	σ σ T_1 T_2 T_3	*
	σ σ T_1 T_2 T_3	**!

We must also posit markedness constraints against contour tones to rule out the possibility of aligning all the tones to the rightmost syllable. These constraints are defined in (11). Obviously, these constraints must outrank ALIGN-R, as shown by the tableaux in (12).

(11) a. $*T_1T_2$: no HL or LH contour is allowed on any syllable.
b. $*T_1T_2T_3$: no HLH or LHL contour is allowed on any syllable.

(12)

a.

	σ σ $T_1T_2T_3$	$*T_1T_2T_3$	ALIGN-R
☞	σ σ $T_1T_2T_3$		*
	σ σ $T_1T_2T_3$	*!	

b.

	σ σ T_1 T_2	$*T_1T_2$	ALIGN-R
☞	σ σ T_1 T_2		*
	σ σ T_1 T_2	*!	

But the presence of ALIGN-R incorrectly predicts that when two tones are mapped onto three syllables, the first tone should be mapped onto the the first two syllables, as shown in (13).

(13)

	σ σ σ T_1 T_2	ALIGN-R
	σ σ σ T_1 T_2	**!
💣	σ σ σ T_1 T_2	*

We may try to remedy the situation by using the ALIGN-L constraint defined in (3). If we rank ALIGN-L over ALIGN-R, we derive the correct output for (13), as shown in (14). But we observe immediately that the tableaux in (12) now give the wrong result. For example, when three tones are mapped onto two syllables, the contour tone now occurs on the initial syllable instead of the final syllable, as illustrated in (15).

(14)

	σ σ σ / T_1 T_2	ALIGN-L	ALIGN-R
☞	σ σ σ / T_1T_2	*	**
	σ σ σ / T_1 T_2	**!	*

(15)

	σ σ / $T_1T_2T_3$	ALIGN-L	ALIGN-R
	σ σ / $T_1T_2T_3$	**!	*
💣	σ σ / $T_1T_2T_3$	*	**

I argue that the problem here is a conceptual one rather than a technical one. The conflict lies between the left-to-right mapping mechanism, which requires a higher ranking of ALIGN-L, and the attraction of contours to the final syllable, which requires a higher ranking of ALIGN-R. Therefore, in order for the analysis to work, the desired effect of *one* of the ALIGN constraints must be achieved by other means.

2.3. Second Try: ALIGN-L and *T_1T_2-$\sigma_{nonfinal}$

I propose that the solution to the problem is to eliminate ALIGN-R from the constraint composition and achieve the same effect by referring to the final syllable in the word as a privileged position for contour-bearing. For ALIGN-L, we can find motivations for it in numerous psycholinguistic studies which illustrate the importance of word-initial position in lexical access and word recognition, e.g., studies by Marslen-Wilson and colleagues (see summary in Marslen-Wilson 1989). But for ALIGN-R, no such motivations can be found. The only reason why contour tones are preferred on the final syllable is a phonetic one: final syllables are subject to final-lengthening and thus have a longer duration. Under this view, the irresolvable conflict mentioned above becomes a resolvable one: tones prefer to occur closer to the left edge of the word for the ease of processing, but contour tones can only occur on the final syllable because of its extended duration.

To capture this effect, I propose two positional tonal markedness constraints, as in (16).

(16) a. *T_1T_2-$\sigma_{nonfinal}$: no HL or LH is allowed on a nonfinal σ.
b. *$T_1T_2T_3$-$\sigma_{nonfinal}$: no HLH or LHL is allowed on a nonfinal σ.

According to the *Pāṇini's Theorem* of constraint ranking (Prince and Smolensky 1993), the constraints in (16) observe *a priori* rankings with the constraints in (11), as shown in (17).

(17) a. $*T_1T_2T_3\text{-}\sigma_{nonfinal}$ » $*T_1T_2T_3$.
b. $*T_1T_2\text{-}\sigma_{nonfinal}$ » $*T_1T_2$.

The tableau in (18) illustrates the effect of ALIGN-L when two tones are mapped onto three syllables.

(18)

σ σ σ T_1 T_2	ALIGN-L
☞ σ σ σ T_1 T_2	*
σ σ σ T_1 T_2	**!

For three tones mapping onto two syllables, I posit the ranking in (19). The high ranking of $*T_1T_2T_3\text{-}\sigma_{nonfinal}$ and $*T_1T_2\text{-}\sigma_{nonfinal}$ ensures that the contour tone occurs on the final syllable, as shown in the tableau in (20). The last two candidates, although fare better with ALIGN-L, lose for violating the more highly ranked $*T_1T_2\text{-}\sigma_{nonfinal}$ and $*T_1T_2T_3\text{-}\sigma_{nonfinal}$.

(19) $*T_1T_2T_3\text{-}\sigma_{nonfinal}$, $*T_1T_2\text{-}\sigma_{nonfinal}$ » ALIGN-L

(20)

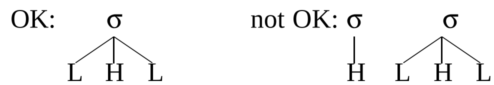
σ σ T_1 T_2 T_3	$*T_1T_2T_3\text{-}\sigma_{nonfinal}$	$*T_1T_2\text{-}\sigma_{nonfinal}$	$*T_1T_2T_3$	$*T_1T_2$	ALIGN-L
☞ σ σ T_1 T_2 T_3				*	**
σ σ T_1 T_2 T_3		*!		*	*
σ σ T_1 T_2 T_3	*!	*	*	*	

The complete constraint ranking emerges as in (21). This ranking derives all the correct output patterns for Pseudo-Kukuya.

(21)

$*T_1T_2T_3T_4$, etc
⇓
MAX(TONE), $*T_1T_2T_3\text{-}\sigma_{nonfinal}$, $*T_1T_2\text{-}\sigma_{nonfinal}$
⇓
$*T_1T_2T_3$, $*T_1T_2$, ALIGN-L
⇓
IDENT(TONE)

I thus conclude that the final position in a prosodic domain must be referred to as a privileged contour carrier in languages with non-distinctive tonal association. The data pattern of Pseudo-Kukuya does not establish the need to refer to word length to account for the fact that syllables in shorter words are more tolerant of contour tones. For example, that the complex contour LHL can occur on monosyllabic words, but not on syllables of disyllabic words can be due to the fact that LHL is a possible tonal melody while HLHL is not, as shown in (22). Therefore the data pattern can be captured by positing a high-ranking *HLHL-WORD constraint, and no specific mention of word length is necessary.

(22)


But if HLHL *is* a possible tonal melody in the language, specifically, if it can be found on polysyllabic words, but not on disyllabic words, then it is justified to say that the lack of LHL on syllables in disyllabic words is due to a high-ranking constraint in the nature of *LHL-$\sigma_{disyllabic}$, which intrinsically outranks *LHL-$\sigma_{monosyllabic}$. When the faithfulness constraint MAX(TONE) intervenes between the two, LHL will be able to surface on monosyllabic words, but not on syllables in disyllabic words. Mende, whose analysis I turn to in section 3, will illustrate this point.

2.4. Zoll (1997)

A similar approach to the attraction of contour tones on the final syllable has been proposed by Zoll (1997). In her account, the effect is captured by constraint ALIGN-R(CONTOUR). Her account is different from the one advanced above in two respects.

First, using an ALIGN constraint implies that the closer the contour is to the prosodic boundary, the better the constraint is satisfied. Therefore we would expect that all else being equal, the penult is a better docking site for contours than the antepenult. But in Zhang (in preparation)'s contour-tone typology, no languages like this are found. It seems that the distinction is of an "all or nothing" nature. Therefore, licensing constraints such as *$T_1T_2T_3$-$\sigma_{nonfinal}$ and *T_1T_2-$\sigma_{nonfinal}$, which directly refer to nonfinal syllables, are better suited for the task. Zoll, in her 1996 dissertation, in fact realizes this problem and proposes a constraint COINCIDE, which requires a marked structure to coincide with a strong constituent.

Second, Zoll's account does not encode the rationale for having contours on the final syllable, while the account I propose clearly states that the durational advantage is crucial to the contour licensing conditions. This is done by assuming that speakers form tonal markedness constraints such as *T_1T_2-$\sigma_{nonfinal}$ according to their phonetic experience. Under Zoll (1997)'s account, it should be equally possible to have a high ranking ALIGN-L(CONTOUR) constraint, which will have the effect of attracting contours to the initial syllable when all else is equal. This is again unattested in Zhang's typology. And given that Zoll (1996)'s COINCIDE approach does not provide specific predictors for where the 'strong constituent' is, there is no *a priori* reason for us to rule out any nonfinal positions, especially the initial position, to constitute a strong constituent for contour tones.

3. Distinctive Tonal Association—Mende

Mende is another celebrated tonal melody mapping language. Leben (1971, 1973, 1978) claims that there are five basic melodic patterns in Mende: H, L, HL, LH and LHL. These patterns are mapped onto syllables in the word one-to-one, left-to-right. The examples in (23) illustrate these melodic patterns in words up to three syllables (from Leben 1978):

(23) Mende examples:

	σ		σσ		σσσ	
H	kɔ́	'war'	pɛ́lɛ́	'house'	háwámá	'waistline'
L	kpà	'debt'	bɛ̀lɛ̀	'trousers'	kpàkàlì	'tripod chair'
HL	mbû	'owl'	ngílà	'dog'	félàmà	'junction'
LH	mbǎ	'rice'	fàndé	'cotton'	ndàvúlá	'sling'
LHL	mba᷈	'companion'	nyàhâ	'woman'	nìkílì	'groundnut'

Dwyer (1971, 1978, 1985) challenges Leben's tonal melody mapping view of tone in Mende. He claims that tones are associated with syllables underlyingly. His major contentions are two. First, the five tonal patterns Leben provides account for at most 90% of the Mende lexicon. Other patterns, such as HLH and HLHL are also attested, illustrated by examples in (24). Second, the mapping analysis cannot formally capture the following contrasts: HL and HH͡L in disyllables; HLL and HHL, LHH and LLH in trisyllables. But these contrasts exist in Mende, as shown (25).

(24) a. HLH: yámbùwú 'tree (sp)'
lánsàná 'proper name'
b. HLHL: náfàlê 'raphia clothed clown'
njéngùlû 'tarantula'

(25) a. HL: káli̇̀ 'hoe' ngílà 'dog'
HH͡L: kɔ́nyɔ̂ 'friend' hókpô 'navel'
b. HLL: félàmà 'junction' mɔ́lìmɔ̀ 'Muslim'
HHL: símbítì 'spider' kɔ́kɔ́lì 'seek'
c. LHH: ndɛ̀ndɛ́lí 'shade' ndàvúlá 'sling'
LLH: lèlèmá 'praying mantis' kòlòbé 'none'

Dwyer hence contends that tones in Mende must be prelinked to the TBUs in the underlying representation rather than associated to TBUs by the *Association Conventions* during the course of the derivation.

The major criticism held toward Dwyer's prelinking ('segmental' in Dwyer's term) analysis is that it overgenerates tonal patterns that are not attested. For example, Conteh et al. (1983) list the following patterns in trisyllabic words that are predicted by the prelinking analysis, but not attested in Mende:

```
(26) a. CVCVCV     b. CVCVCV      c. CVCVCV      d. CVCVCV
        /|  |  |       /|  |  |\      /|  /|  |\       |  |\  |\
       HL  H  H       HL  H  HL      HL  HL  HL        H  HL  HL

     e. CVCVCV        f. CVCVCV      g. CVCVCV
         |  |\  |\        /|  |  |       /|  /|  |
         L  HL  HL       HL  H  L       HL  HL  H
```

But as we can see, all patterns listed in (26) involve H͡L contours on syllables in non-final position. We have argued that this effect can be construed as the privilege of the final syllable in a prosodic domain to carry tonal contours as it is subject to final lengthening. Therefore, if aided by reference to the final syllable as a privileged contour carrier, the analysis does not necessarily overgenerate any of the patterns in (26).

But contour tones on non-final syllables are in fact attested in Mende. Dwyer (1978) lists a number of words with a HL or LH contour on non-final syllables, and these syllables invariably have a long vowel, as in (27).

(27)	L͡HH:	bèésí	'pig'
	L͡HL:	nyàápò	'mistress'
	H͡LL:	wóòmà	'back'

Leafing through Innes' *Mende-English Dictionary* (1969), not only do we find numerous examples of this sort, we also find long vowels with level tones, e.g., *sɔ̀ɔ̀ 'long'* and *nɛ́ɛ́ 'boil'*. Therefore vowel length does seem to be contrastive in Mende, even though Leben is not willing to commit to such a view. Dwyer also argues that the monosyllabic word for *'companion'* in (23), which carries a LHL contour, should be transcribed with a long vowel—*mbàâ*. This argument finds support in Spears (1967) and Innes (1969), both of which transcribe the word with a long vowel.

The final complication of the Mende data is on the surface realization of its rising tone LH. On a long vowel, a rising tone can surface as such, as illustrated by words like *bèésí 'pig'* in (27). But on a short vowel, the rising tone usually behaves as a 'polarized tone': it surfaces as a downstepped H before a pause or L, and as a L before a H which is subsequently downstepped. This is illustrated by (28) (Dwyer 1978: 182).

(28) UR	Surface before #	Surface before L	Surface before H
L͡H njǎ	nj!á	nj!á-fèlé	njɛ̀-!ɪ́
	'water'	'two rivers'	'the water'

If the above generalizations about the rising tone are true without exceptions, we are inevitably led to the conclusion that the rising tone L͡H can only occur on long vowels. But Leben (1973: 187) claims that the words for *'rice'* (*mbǎ*) and *'kill'* (*pǎ*) do have a rising pitch. He further asserts that the simplification of the rising tone does not apply to monosyllabic nouns and verbs. This statement is obviously in disagreement with the data in (28), which show rising simplification on a monosyllabic noun. Therefore it is plausible that the Downstepped High, or rather, Mid, is a contrastive tone in Mende. But with the scarcity of data, I cannot make any definitive statement about this. The relevant point here is the following: if a rising pitch *is to* occur on a short vowel, it can only occur on monosyllabic nouns or verbs. This statement does not contradict either of the data sources—Leben (1973) and Dwyer (1978).

We are thus led to the following picture regarding the distribution of contour tones in Mende. Long vowels can carry a complex contour LHL in monosyllabic words; they can carry a simple contour HL or LH in other positions. Short vowels can carry either of the simple contours HL and LH in monosyllabic words; they can carry the falling contour HL in the final position of di- or polysyllabic words; they cannot carry contours in other positions. These generalizations are summarized in (29).

(29)

Vowel length	Syllable count	Syllable position	Complex ok?	Rise ok?	Fall ok?
VV	1	final	**yes**	**yes**	**yes**
VV	>1	any	no	**yes**	**yes**
V	1	final	no	**yes**	**yes**
V	>1	final	no	no	**yes**
V	>1	non-final	no	no	no

From this table, we can see that the contour limitations in Mende are largely due to durational restrictions instead of restrictions on tonal melodies. For example, LHL can occur on long vowels in monosyllabic words, but not in disyllabic words. This is not due to the lack of the HLHL pattern, as is the case in Kukuya. Rather, HLHL can occur on trisyllabic words as in *náfàlê ‘raphia clothed clown’* (cf. (24)). But it does not occur on disyllabic words, nor does LLHL occur on disyllabic words (with IDENT(TONE) ranked over alignment constraints as discussed in section 1, this would have been entirely possible). Both of these scenarios would result in a LHL contour, as shown in (30).

(30)

Therefore, I propose to account for the tonal patterns in Mende with the constraint family defined in (31). The constraints in this family are intrinsically ranked, according to the two principles in (32). The principle in (32a) ensures that a contour tone is allowed on a longer syllable before it is allowed on a shorter syllable, and the principle in (32b) ensures that a syllable allows a contour that requires a shorter duration before it allows a contour that requires a longer duration. Both of these principles are projected from phonetics.

(31) *CONTOUR$_i$-σ_j: contour *i* cannot occur on syllable type *j*.

(32) a. If the sonorous portion of the rime in σ_m is longer than σ_j, then *CONTOUR$_i$-σ_j » *CONTOUR$_i$-σ_m.

b. If contour_i requires a longer duration than contour_n, then $\text{*CONTOUR}_i\text{-}\sigma_j$ » $\text{*CONTOUR}_n\text{-}\sigma_j$.

Specifically for Mende, the relevant contour types, in descending order of the time they require, are LHL, LH, and HL. The fact that a rising tone takes longer to be implemented than a falling tone with equal pitch excursion is established in Sundberg (1979). The sonorous rime duration of the syllables in Mende is systematically affected by three parameters: vowel length ($\sigma_{VV} > \sigma_V$), position of the syllable in the word ($\sigma_{final} > \sigma_{nonfinal}$), and syllable count in the word ($\sigma_{monosyllabic} > \sigma_{polysyllabic}$, where 'polysyllabic' here represents two or more syllables). If we assume that long vowels are longer than short vowels in any situation, then the syllable types in Mende can be ordered in descending sonorous rime duration as: $\sigma_{VV\text{-monosyllabic}}$, $\sigma_{VV\text{-polysyllabic-final}}$, $\sigma_{VV\text{-polysyllabic-nonfinal}}$, $\sigma_{V\text{-monosyllabic}}$, $\sigma_{V\text{-polysyllabic-final}}$, and $\sigma_{V\text{-polysyllabic-nonfinal}}$. Therefore, the relevant constraints in the $\text{*CONTOUR}_i\text{-}\sigma_j$ family and their intrinsic rankings in Mende can be shown as in (33). In (33), MS=monosyllabic, PS=polysyllabic, F=final, NF=nonfinal.

(33) Mende $\text{*CONTOUR}_i\text{-}\sigma_j$ constraint family:

*LHL-$\sigma_{V\text{-PS-NF}}$	»	*LHL-$\sigma_{V\text{-PS-F}}$	»	*LHL-$\sigma_{V\text{-MS}}$	»	*LHL-$\sigma_{VV\text{-PS-NF}}$	»	*LHL-$\sigma_{VV\text{-PS-F}}$	»	*LHL-$\sigma_{VV\text{-MS}}$
∨		∨		∨		∨		∨		∨
*LH-$\sigma_{V\text{-PS-NF}}$	»	*LH-$\sigma_{V\text{-PS-F}}$	»	*LH-$\sigma_{V\text{-MS}}$	»	*LH-$\sigma_{VV\text{-PS-NF}}$	»	*LH-$\sigma_{VV\text{-PS-F}}$	»	*LH-$\sigma_{VV\text{-MS}}$
∨		∨		∨		∨		∨		∨
*HL-$\sigma_{V\text{-PS-NF}}$	»	*HL-$\sigma_{V\text{-PS-F}}$	»	*HL-$\sigma_{V\text{-MS}}$	»	*HL-$\sigma_{VV\text{-PS-NF}}$	»	*HL-$\sigma_{VV\text{-PS-F}}$	»	*HL-$\sigma_{VV\text{-MS}}$

The remaining task for the Mende account is to rank the tonal faithfulness constraints MAX(TONE) and IDENT(TONE) against the $\text{*CONTOUR}_i\text{-}\sigma_j$ constraint family. According to the table in (29), for LHL, since it can only occur on a long vowel in a monosyllabic word, for the first row of markedness constraints in (33), the faithfulness constraints should be ranked just above *LHL-$\sigma_{VV\text{-MS}}$. Likewise, we deduce the ranking of the faithfulness constraints against the other two rows of tonal markedness constraints. The complete ranking of Mende is shown in (34).

I have thus shown that for a representative language with distinctive tonal association, the analysis must refer to the final position as well as the syllable count in the word in order to account for its distribution of contour tones. Of course, there is the question whether all languages with distinctive tonal association behave like Mende, namely, the contour restrictions can only be accounted for by constraints of the nature $\text{*CONTOUR}_i\text{-}\sigma_j$, not by constraints on tonal melodies such as *HLHL-WORD. Zhang (in preparation) suggests that this is typically the case. For more detailed discussion on this point, see Zhang (in preparation).

(34) Mende ranking:

	»	»
$*LHL\text{-}\sigma_{V\text{-}PS\text{-}NF}$ $*LHL\text{-}\sigma_{V\text{-}PS\text{-}F}$ $*LHL\text{-}\sigma_{V\text{-}MS}$ $*LHL\text{-}\sigma_{VV\text{-}PS\text{-}NF}$ $*LHL\text{-}\sigma_{VV\text{-}PS\text{-}F}$	MAX(TONE) IDENT(TONE)	$*LHL\text{-}\sigma_{VV\text{-}MS}$
$*LH\text{-}\sigma_{V\text{-}PS\text{-}NF}$ $*LH\text{-}\sigma_{V\text{-}PS\text{-}F}$		$*LH\text{-}\sigma_{V\text{-}MS}$ $*LH\text{-}\sigma_{VV\text{-}PS\text{-}NF}$ $*LH\text{-}\sigma_{VV\text{-}PS\text{-}F}$ $*LH\text{-}\sigma_{VV\text{-}MS}$
$*HL\text{-}\sigma_{V\text{-}PS\text{-}NF}$		$*HL\text{-}\sigma_{V\text{-}PS\text{-}F}$ $*HL\text{-}\sigma_{V\text{-}MS}$ $*HL\text{-}\sigma_{VV\text{-}PS\text{-}NF}$ $*HL\text{-}\sigma_{VV\text{-}PS\text{-}F}$ $*HL\text{-}\sigma_{VV\text{-}MS}$

4. Conclusion

In this paper, I have formally explored the possibility of explaining the gravitation of contour tones to the final position of a prosodic domain and shorter words by using the notion of tonal melody and alignment constraints without specifically referring to positional properties of these syllables *per se*. The conclusion is that in both languages with and without distinctive tonal association, the analysis cannot completely do without referring to the advantage that these properties induce for contour bearing. Therefore, I claim that the final position in a prosodic domain and the syllable count in a word must be relevant for phonological analyses of the positional prominence effects regarding contour tones. Speakers are aware of the durational advantage, and hence the advantage on contour-tone bearing, that these factors may induce, and construct their phonologies accordingly.

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