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Problems in Kuria H tone assignment

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Abstract In the Buguumbe dialect of Kuria, the assignment of inflectional H tones to the verb poses at least two theoretically significant problems. First, the principles of tone assignment count to four and are not amenable to a metrical analysis, which is problematic for theories of locality. Second, for at least some speakers, the principles of tone assignment are phrase-level processes that refer to the internal structure of the verbal word, which is problematic for the notion of Bracket Erasure within Lexical Phonology.

Keywords Counting · Tone · Bantu · Lexical Phonology · Prosodic domains

1 Mora-counting H tone assignment in Kuria

Kuria is a 'predictable' Bantu tone language (Odden 1989), which lacks lexical tonal contrasts in verb roots: all verb roots are underlyingly toneless (/Ø/). Verbal tone patterns are determined primarily by inflectional H tones that are assigned by rule to different positions of the stem to mark tense-aspect-mood-polarity, focus, and clause-

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type distinctions—distinctions that are henceforth referred to simply as 'tense' distinctions.[1]

Most verbal forms in Kuria are inflected with one of four basic tonal patterns that we refer to here as 'melodies'. These four melodies, illustrated in (1), are characterized by a H tone (the 'melodic H') that is assigned to one of the first four moras of the verb stem, depending on the tense (Mwita 2008; Odden 1987).[2] (In the examples below, the stem boundaries are marked with '[' and ']'.) Both the surface location of the H and the very presence of the H are determined by the tense category, since at least one tense (namely, the Hortatory Imperative) lacks a melodic H (Mwita 2008:134–135). In tonally inflected tenses, the melodic H spreads rightward from its assigned position onto any and all non-phrase-final moras.[3] Tenses with the μ1 melody, such as the Past, thus have a H tone that begins on the initial mora of the stem and extends rightward to the penult. In μ2 tenses, the melodic H begins on the second mora of the stem. And so on: the μ3 melodic H begins on the third stem mora, and the μ4 melody begins on the fourth stem mora. For clarity, the mora targeted by the melodic H is underlined.[4,5]

(1) Basic tonal melodies of Kuria

μ1	n-to-o-[hó́ótóótér-a]	Past[6]
	foc-1pl-tns[reassure-fv]	
	'we have reassured'	
μ2	n-to-oka-[hoó́tóóté-éy-e]	Past Progressive
	foc-1pl-tns[reassure-pfv-fv]	
	'we have been reassuring'	
μ3	n-to-re-[hootóó́tér-a]	Remote Future
	foc-1pl-tns[reassure-fv]	
	'we will reassure'	

[1] More precisely, H tone is assigned to the 'macrostem', a constituent that includes the 'stem' plus any preceding object markers (Mwita 2008; Odden 1987). Lacking any object markers, the macrostem and stem are equivalent. Since all of the data presented below lack object markers, we will refer to the 'macrostem' as the 'stem'.

[2] Data presented here are from the Buguumbe dialect of the Kuria District of southwestern Kenya and are taken mainly from Mwita (2008), whose data are based primarily, though not exclusively, on the speech of the author, Leonard Chacha Mwita. We have consulted with an additional speaker of the Buguumbe dialect, Johnes Kitololo, whose data differ somewhat from those presented in Mwita (2008). We discuss those differences in the relevant sections below and henceforth refer to our consultant as 'JK'.

[3] Spreading operates somewhat differently in the Nyabaasi dialect of Kuria; see Odden (1987) and Cammenga (2004) for details.

[4] JK produces the verb forms in (1) with the exact same tone patterns as Mwita does, but with open mid vowels throughout the stem in the Past, Remote Future, and Inceptive. Our analysis is that the speakers differ in having /-hootoot-/ vs. /-hɔɔtɔɔt-/ as underlying forms of this root.

[5] We use the following abbreviations in interlinear glosses:

aug = augment	foc = focus	fv = final vowel
inf = infinitive	neg = negation	pfv = perfective
tns = tense-aspect		

[6] We have simplified some of the labels for tenses found in Mwita (2008). For example, what we are calling 'Past' here is the 'Untimed Past Anterior Focused' in Mwita (2008), and this example is glossed '(indeed) we have (already) reassured (anytime before now)'. JK translated this form simply as 'we reassured'.

μ4	to-ra-[hootoó̲tér-a]	Inceptive
	1pl-tns[reassure-fv]	
	'we are about to reassure'	

One of the main empirical issues we are concerned with in this paper is the tonal pattern of the μ3 and μ4 melodies in phrase-final and phrase-medial contexts when there are fewer than three or four moras in the stem. The data in (2) illustrate the tonal patterns of the μ4 melody with data from the Inceptive tense. If there are four or more moras in the stem, as in (2a), the melodic H begins on the fourth mora of the stem and spreads rightward to any and all non-final moras. Here we see clearly that moras are the relevant unit counted in melodic H assignment since a syllable with a long vowel is functionally equivalent to two syllables with short vowels. If there are three moras in the stem, as in (2b), a LH rising tone is realized on the stem-final syllable.[7] If there are fewer than three moras in the stem, as in (2c), the stem is realized all L. For some speakers, there is evidence that the melodic H remains floating, which is represented here by superscript ^{H}. This evidence will be discussed below.

(2) μ4 melody: Inceptive 'we are about to . . . ' (1pl-tns-[root-fv])

a.	to-ra-[heetok-á̲]	'remember'
	to-ra-[karaaŋg-á̲]	'fry'
	to-ra-[taaŋgaá̲s-a]	'announce'
	to-ra-[teremek-á̲]	'be calm'
	to-ra-[turuuŋá̲n-a]	'welcome'
	to-ra-[koondokó̲r-a]	'uncover'
	to-ra-[kiriɣií̲t-a]	'scrub'
	to-ra-[hootoó̲tér-a]	'reassure'
b.	to-ra-[saamb-ă̲]	'burn'
	to-ra-[sukur-ă̲]	'rub'
c.	to-ra-[rom-a]^{H}	'bite'
	to-ra-[βun-a]^{H}	'break'
	to-ra-[ry-a]^{H}	'eat'
	to-ra-[sy-a]^{H}	'grind'

The same general patterns are illustrated by the Remote Future Focused forms with the μ3 melody in (3). If there are three or more moras in the stem, as in (3a), the melodic H appears on the third mora of the stem and spreads to any and all non-final moras. If there are two moras in the stem—one fewer than the melodic target, as in (3b)—a rising tone is realized on the stem-final mora. If there is one mora in the stem—two fewer than the melodic target, as in (3c)—the stem mora is L, and the melodic H remains floating.

[7] Some speakers produce a final phonetically M tone in these forms, which Mwita (2008) interprets as a downstepped H, created as the result of the delinking of L. (This is one of two contexts described as having downstep in Kuria; the other is an optional realization of HLH as H$^{!}$HH: for some speakers, forms such as oɣo[térémek-á] 'to be calm' freely vary with oɣo[téré$^{!}$mék-á]. Other contexts where distinct Hs become adjacent are not realized with downstep.) JK has a third phonetic pattern with stems of three or fewer moras, which are realized with final L. Our analysis is that for this speaker the H tone does not associate to the stem unless a fourth mora is underlyingly present; thus JK lacks rules of Final Lengthening and Final Shortening discussed below.

(3) μ3 melody: Remote Future Focused ‘we will . . . ’ (foc-1pl-tns-[root-fv])

a.	n-to-re-[saamb-á]	‘burn’
	n-to-re-[tɛrɛk-á]	‘brew’
	n-to-re-[heetók-a]	‘remember’
	n-to-re-[karaáŋg-a]	‘fry’
	n-to-re-[taaŋgáás-a]	‘announce’
	n-to-re-[teremék-a]	‘be calm’
	n-to-re-[turuúŋán-a]	‘welcome’
	n-to-re-[koondókór-a]	‘uncover’
	n-to-re-[kiriɣíít-a]	‘scrub’
	n-to-re-[hootóótér-a]	‘reassure’
b.	n-to-re-[rom-ă]	‘bite’
	n-to-re-[βun-ă]	‘break’
c.	n-to-re-[ry-a]^{H}	‘eat’
	n-to-re-[h-a]^{H}	‘give’

The μ1 and μ2 patterns straightforwardly follow the same generalizations as the μ3 and μ4 patterns described above. The data in (4) show that the H of the μ1 pattern is realized on all stem moras up to the penult.

(4) μ1 melody: Untimed Past Anterior Focused ‘(indeed) they have (already). . . ’ (foc-1pl-tns-[root-fv])

n-to-o-[ry-á]	‘eaten’
n-to-o-[róm-a]	‘bitten’
n-to-o-[sáámb-a]	‘burned’
n-to-o-[tɛ́rɛ́k-a]	‘brewed’
n-to-o-[héétók-a]	‘remembered’
n-to-o-[kárááŋg-a]	‘fried’
n-to-o-[tááŋgáás-a]	‘announced’
n-to-o-[téréмék-a]	‘been calm’
n-to-o-[túrúúŋán-a]	‘welcomed’
n-to-o-[kóóndókór-a]	‘uncovered’
n-to-o-[kíríɣíít-a]	‘scrubbed’
n-to-o-[hóótóótér-a]	‘reassured’

As shown in (5), the H of the μ2 pattern is realized on all stems with two or more moras. The tense that exemplifies this tone pattern, the Past Progressive, is marked by a final suffix combination *-er-e*.[8] The concatenation of this suffix with the root produces stems with at least three moras, which allows the μ2 melodic pattern to be realized straightforwardly in all verb forms.

(5) μ2 melody: Past Progressive ‘we have been. . . ’ (foc-1pl-tns-[root-pfv-fv])

a.	n-to-oka-[rom-ér-e]	‘biting’
	n-to-oɣa-[saámb-ér-e]	‘burning’
	n-to-oɣa-[terék-ér-e]	‘brewing’

[8]This suffix combination undergoes vowel harmony and a pattern of allomorphy called ‘imbrication’, producing forms ending in *-oye*, *-eye*, *-ini*, etc. See Mwita (2008) for details.

	n-to-oka-[he̲é̲tók-ér-e]	‘remembering’
	n-to-oɣa-[kará̲á̲ŋg-ér-e]	‘frying’
	n-to-oɣa-[taá̲ngáás-ér-e]	‘announcing’
	n-to-oɣa-[teré̲mék-ér-e]	‘being calm’
	n-to-oɣa-[turú̲úŋá-ín-i]	‘welcoming’
	n-to-oɣa-[koó̲ndókó-óy-e]	‘uncovering’
	n-to-oɣa-[kiríɣíít-ír-e]	‘scrubbing’
	n-to-oka-[hoó̲tóóté-éy-e]	‘reassuring’
b.	n-to-oka-[re-é̲y-e]	‘eating’

Evidence that the melodic H persists in short verb stems such as *to-ra-*[*rom-a*]^{H} ‘we are about to bite’ and *n-to-re-*[*ry-a*]^{H} ‘we will eat’ comes from the fact that these forms fail to undergo a rule of Superlowering, which lowers phrase-final L to Superlow (SL) after L. Superlowering occurs, for example, in the Hortatory Imperative, as shown in (6). Final L becomes SL (marked by a grave accent) when preceded by a L as in (6a), but this Superlowering rule does not apply in (6b) when the final L is not preceded by another L tone.[9]

(6) Lowering to SL in the Hortatory Imperative ‘(do) V!’ (tns-[root-fv])

a.	ta-[súkur-à]	‘rub’
	ta-[káraaŋg-à]	‘fry’
	ta-[héétok-à]	‘remember’
b.	ta-[róm-a]	‘bite’
	tá-[ry-a]	‘eat’

The rule of Superlowering is formalized in (7).[10] Note that the rule is triggered by two separate L tones on the final two moras of the phrase; words like the ones in (6a) get their surface L tones via a default L insertion rule to be discussed momentarily.

(7) Superlowering

L L → SL
| |
μ μ]PHRASE

In the present analysis, Inceptive forms such as *to-ra-*[*rom-a*]^{H} ‘we are about to bite’, which surface with L on the final two moras of the stem, fail to undergo Superlow-

[9]There is a complementary relationship between the environments in which Superlowering is found and those in which rightward spread is found. Spread produces surface forms with H on the penult, which therefore lack final LL sequences and do not undergo Superlowering. The constructions that lack rightward spread include several imperatives—the Hortatory Imperative 1, the Hortatory Imperative 2, and the Mandatory Imperative—and many (but not all) negative tenses (see Mwita 2008:185–186). We assume that Superlowering is not a tense-specific rule and thus only fails to apply when its phonological environment is not met, but Spread is restricted to (or blocked in) specific morpho-syntactic contexts.

[10]A reviewer asks whether Superlowering is necessarily part of the phonology of the language. Evidence for the phonological status of the rule comes from the fact that there is a surface contrast between [. . . L L #] and [. . . L SL #] in examples such as *to-ra-*[*rom-a*] ‘we are about to bite’ (Mwita 2008:117; see (2c) above) vs. *βa-ta-re-*[*rom-à*] ‘they will not bite (then)’ (Mwita 2008:198). Nevertheless, Superlowering is a late rule that applies after Default L Insertion. Moreover, Not all speakers have the Superlowering rule. JK produces all of the forms in (6a–b) with identical level low tones on the final mora.

ering because stem-final L is not phrase-final, due to the presence of the melodic H. Thus, we can use Superlowering as a diagnostic for the presence of a floating melodic H after the stem.

To summarize the data from Mwita (2008) so far, we can see that there is a three-way distinction in the realization of the melodic H. The melodic H is realized on the stem as H on the appropriate stem mora if there are at least as many moras in the stem as targeted by H Tone Assignment (2a, 3a). The melodic H is realized as a LH rising tone on the stem-final mora if there is one mora too few in the stem (2b, 2b). If there are two or more moras too few in the stem, the melodic H is not realized on the stem (the stem is all L), but the melodic H persists, floating (2c, 3c). The main analytical challenge is accounting for the difference between final LH and final L when there is one mora too few vs. two moras too few in the stem. How is it that the melodic H is allowed to attach to the stem when there is one mora too few but not two moras too few?

We analyze all forms with the μ4 pattern via the rules in (8).[11] This includes the rule of melodic H assignment that assigns H to the fourth mora of the stem.[12] For completeness, we have also provided our spreading rule, which spreads H iteratively to the right within the phrase, provided there is a toneless mora immediately following the target, and Default L Insertion, which inserts L on any toneless mora.[13]

(8)

H Tone Assignment (μ4)	*Spread*		*Default L Insertion*
H’	H	(Iterative;	L ← Ø
¦	⌈ ⋱	domain:	¦
STEM[μ μ μ μ	μ μ μ’	phrase)	μ’

These rules provide a straightforward account of the tonal patterns of verb stems of four or more moras. An example derivation for long verb stems is provided in (9).

(9) Four or more moras: *to-ra-*[*teremek-á*] ‘we are about to be calm’

HTA (μ4)		*Default L*
H		L L L L L H
¦		| | | | | |
to-ra-[teremek-a]	→	to-ra-[teremek-a]

To account for forms with fewer than four moras, we posit the additional rules in (10). These rules include Final Lengthening, which adds a mora to every phrase-final syllable. This rule has the effect of providing stems with one too few underlying moras with the extra mora they need to accommodate the melodic H. Stems with one too few underlying moras surface with a rising tone in final position because the

[11] Note that an apostrophe indicates an unlinked element, so H’ is a floating H tone, while μ’ is a toneless mora.

[12] The formalization of melodic H assignment in (8), as in the other rules of melodic H assignment in (13) below, omits the specific tenses that the rule applies in. We have not been able to identify consistent semantic or morpho-syntactic features that define the tenses in which each of the rules of melodic H assignment apply, so we follow Mwita (2008) in assuming that each of these rules of melodic H assignment contains a listed set of tenses in which these rules apply and the various H association rules refer to these morphosyntactic features.

[13] There is a NonFinality condition on Spread, which prevents spreading into the phrase-final syllable.

melodic H links to the second mora of the lengthened phrase-final syllable, which becomes a LH sequence due to Default L Insertion.

(10)

Final Lengthening	*Final Shortening & Reassociation*	*Fall Elimination*
μ μ ← Ø	T_1 T_2	H L → Ø
σ]$_{PHRASE}$	μ μ → Ø	μ]$_{PHRASE}$
	σ]$_{PHRASE}$	

The derived phrase-final long vowels do not surface long, however, because of a rule of Final Shortening, but the LH tonal pattern of the final syllable is preserved. The derivation of *to-ra-*[*sukur-ă*] 'we are about to rub' is shown in (11).[14]

(11) Three moras: to-ra-[sukur-ă] 'we are about to rub'

Final Lengthening		*HTA* (*μ4*)		*Default L*	
H		H		L L L L LH	
to-ra-[sukur-aa]	→	to-ra-[sukur-aa]	→	to-ra-[sukur-aa]	→

Reassociation & Shortening
L L L L LH
to-ra-[sukur-a]

While there is a contrast between rise, level H, and L in phrase-final position, there are no phrase-final falling tones, so forms like *to-ra-*[*heetok-á*] 'we are about to remember' undergo a rule of Final Fall Elimination that levels out intermediate falling tones created on the phrase-final syllable.

Stems with two underlying moras too few (2a, 3a) do not have enough moras to accommodate the melodic H, even after Final Lengthening applies. This is illustrated by the derivation in (12).

(12) Two or fewer moras: to-ra-[rom-a]^{H} 'we are about to bite'

Final Lengthening		*HTA* (*μ4*)		*Default L*	
H				L L L LL H	
to-ra-[rom-aa]	→	Does Not Apply	→	to-ra-[rom-aa]	

Reassociation & Shortening
L L L L H
to-ra-[rom-a]

[14] As suggested by a reviewer, Final Shortening may be unnecessary since there is no contrast between word-final long and short vowels. Final vowels sound short, but we have no evidence that they are phonologically short. Although we can dispense with Final Shortening in our analysis, Final Lengthening is still necessary in order to account for the difference between stems that have one mora too few (where the H does associate to the final vowel) vs. two moras too few (where the H is not realized on the verb at all).

The analysis of the μ3, μ2, and μ1 melodies is identical, except that there are different tense-specific rules of H Tone Assignment that target the third, second, and first mora of the stem, respectively, as shown in (13). Each of these rules applies only in one or more specific tense categories.

(13)

HTA (μ3)	*HTA (μ2)*	*HTA (μ1)*
H'	H'	H'
⋮	⋮	⋮
STEM[μ μ μ	STEM[μ μ	STEM[μ

The main challenge for any analysis of these mora-counting patterns is that in general, phonological computations are assumed not to count beyond two (Hayes 1995:307; Kenstowicz 1994:372). Phonological rules have been claimed to be constrained by a locality condition that does not allow elements to intervene between the target and trigger of a rule. As stated by Hewitt and Prince (1989:178), "[p]honological rules may affect a single element (tier-) adjacent to the rule trigger." For our current purposes, we will define a 'trigger' as all aspects of the phonological environment that must be present in order for a rule to apply, not including the segment, feature, or other element that undergoes the rule. If we assume that the trigger itself must be only a single element (e.g., one mora), then our rules assigning H tone to the third or fourth mora of the stem run afoul of locality, since the trigger in each of the rules in (13) is an arbitrary number of moras following the stem boundary.

We propose that a 'rule trigger' can consist of more than just one phonological element (segment, mora, syllable, foot, etc.). A trigger can consist of any number of elements; in the case of our μ4 HTA rule, the trigger is three moras (μμμ) to the left of the target mora. With this assumption regarding what can be a 'trigger', our analysis is consistent with Hewitt and Prince's proposal regarding locality; our analysis does, however, contradict the widely assumed ban on 'counting' if we consider that the grammar must count moras in order to determine whether the rule trigger is present in a given form. We consider some possible alternatives to our analysis later in Sect. 3; before doing so, we turn in Sect. 2 to the description of a different but related problematic phenomenon involving H Tone Association across word boundaries.

2 H tone association is a phrasal process

The phrasal tonology of Kuria is in need of further dedicated study, but existing data are quite remarkable and potentially have profound implications. In this section, we demonstrate that H Tone Association takes place post-lexically and counts moras following the verb stem and verb word. Mwita (2008) provides data in several contexts showing that the melodic H is assigned to the appropriate mora of a morpheme following the verb: when the verb is followed by a locative enclitic (a fact also noted by Odden 1987), by a second Infinitival verb, by the negative marker *hai*, and by a noun.

The display in (14) provides illustrative data in which a verb with the μ4 melody combines with a following noun, in this case the noun *eɣetóóke* 'banana' (which is underlyingly toneless but receives a default tone in isolation). When there are four or more moras in the stem, as in (14a), we find the expected pattern in which the

melodic H is assigned to the fourth mora of the stem and spreads right to the penult of the phrase. The key data are those in (14b–d) in which there are fewer than four moras in the stem, which show that the melodic H is assigned to the appropriate mora of the following noun if the verb stem has fewer than four moras. If there are three moras in the stem, as in (14b), the melodic H is assigned to the first mora of the following noun. If there are two moras in the stem, as in (14c), the melodic H is assigned to the second mora of the following noun. If there is only one mora in the stem, as in (14d), the melodic H is assigned to the third mora of the following noun.

(14) μ4 melody: Inceptive 'we are about to…' (1pl-tns-[root-fv])

a.	to-ra-[karaaŋg-á] éɣétɔ́ɔ́kɛ	'fry a banana'
b.	to-ra-[sukur-a] éɣétɔ́ɔ́kɛ	'rub a banana'
	to-ra-[tɛrɛk-a] éɣétɔ́ɔ́kɛ	'brew a banana'
c.	to-ra-[rom-a] eɣétɔ́ɔ́kɛ	'bite a banana'
	to-ra-[βun-a] eɣétɔ́ɔ́kɛ	'break a banana'
d.	to-ra-[ry-a] eɣetɔ́ɔ́kɛ	'eat a banana'

The data in (15) show an analogous pattern in a tense with the μ3 tone melody. Here, because the verb stems are too short to bear the melodic H, we see that the H associates to a mora of the object noun, namely, the third mora, counting from the left edge of the stem.

(15) μ3 melody: Remote Future 'we will…' (foc-1pl-tns-[root-fv])

n-to-re-[rom-a] éɣétɔ́ɔke	'bite a banana'
n-to-re-[ry-a] eɣétɔ́ɔke	'eat a banana'

On the standard assumption that the stem is a sub-constituent of the verb word, which combines with a following word at the phrasal level (see e.g. Downing 2003:7), the data in (14)–(15) pose a theoretical problem: H Tone Association must be a phrase-level process that counts moras of the following word, yet it begins counting from the left edge of the stem—a word-internal boundary. According to the Bracket Erasure convention in Lexical Phonology, "[i]nternal brackets are erased at the end of a level" (Kiparsky 1982:11). Thus, under the assumption that stem level phonology is followed by word-level phonology, which is followed by phrasal phonology, all word-internal morpheme boundaries (including the stem boundary) are obliterated at the end of the word level and should not be visible to rules that apply at the phrasal level. Because H Tone Association in Kuria applies at the phrasal level but makes reference to the stem boundary, this is an example of a "lookback effect" (Scheer 2008, 2011), which should not be possible, given Bracket Erasure. Note that it is not the case in Kuria, as it is in some other Bantu languages (Hyman and Ngunga 1994; Odden 1995, 1996, 1998), that tone assignment first fails to apply at the stem or word level, followed by (non-)re-association to the final mora of the verb or initial mora of the following word.

Some alternative conceptions of prosodic domains reject the classical assumptions of Lexical Phonology that (i) the Bantu verb word is a word and the product of the morphology and lexical phonology and (ii) the combination of verb and object is performed by a separate module that feeds into the post-lexical phonology (see Cheng and Downing 2012 for an overview of recent approaches). If these assumptions of

classical Lexical Phonology are dropped, the data are not problematic, as long as the left edge of the (macro)stem defines the left edge of the domain of H Tone Assignment and this domain includes at least the following word. For example, under Julien's (2002:196) analysis of Shona verb structure, the verb stem and the following object are a constituent, MoodP. Similarly, in Cheng and Downing (2012), the verb stem and following object form a constituent under vP. These constituents could possibly serve as the basis for the domain of melodic H assignment in Kuria.

Outside of Kuria, we do not know of other examples in the phonology-syntax interaction literature where there is evidence that the stem parses with the following word, but Hyman (1987) argues that in Kukuya, phonological processes first apply at the stem level, after which point, stems join with prefixes of the following word; i.e., morpho-syntactic prefixes are phonologically enclitics. There is no reported evidence in Kukuya that the prefixes and stem of a single word are parsed together phonologically. Odden (1995) provides an additional example from Yao of a phrasal rule that is sensitive to properties of a preceding stem.

As it turns out, not all Buguumbe Kuria speakers have this dramatic phrasal assignment of tone. For speaker JK, the H of μ4 is not assigned to the appropriate mora of a following noun. Rather, if there are fewer than four moras in the verb stem, the melodic H fails to be assigned to the stem (as in JK's isolation forms; see footnote 7), and a following toneless noun takes a default H tone on the penult (16).

(16) μ4 melody: Inceptive 'we are about to…' [JK] (1pl-tns-[root-fv])

to-ra-[rom-a] eɣetɔ́ɔ́kɛ	'we are about to bite a banana'
to-ra-[ry-a] eɣetɔ́ɔ́kɛ	'we are about to eat a banana'

It appears that for JK, H Tone Assignment applies only at the word or stem level. If the melodic H fails to be associated to the stem at this level, it either remains floating or is stray-erased. In either case, the melodic H receives no phonetic implementation. JK's phrasal level data thus do not pose the same theoretical problems as the data documented in Mwita (2008).

3 Alternatives to mora counting

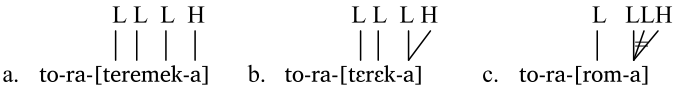
As discussed earlier, the μ3 and μ4 rules of H Tone Association in (8) and (13) are problematic for the standard notion of locality, which requires rule triggers to consist only of one element adjacent to the target. The analysis we proposed in Sects. 1 and 2 above involves rules of H Tone Association that do not adhere to this definition of locality. In this section, we consider three alternative approaches to our mora-counting analysis, showing that all three of the non-counting approaches have shortcomings.

3.1 Melodies

One possible analysis, adopted by Cammenga (2004) in his analysis of Infinitive forms in Kuria, is to derive the stem tonal patterns as the result of multi-tone melodies mapped from left to right across the verb stem. Under this approach, the μ4 and μ3

patterns would have four- and three-tone melodies, LLLH and LLH, respectively.[15] To account for the generalizations involving stems with two moras too few and one mora too few, we need only to add the restriction that two tones are maximally allowed on the final mora. The melodic H fails to surface on the stem when there are two moras too few because this context would involve three tones on the final mora, as shown in (17).

(17) µ4 = LLLH melody



The main problem with this approach is that there is evidence that the moras to the left of the melodic H must be toneless and cannot be L-toned. There are a number of contexts documented in Mwita (2008) in which underlyingly H-toned prefixes spread right by what appears to be the same process that spreads the melodic H: the prefix Hs spread iteratively to the right as long as there is a toneless mora following the target. The Remote Future Negative forms in (18a) have the µ3 melody and the H-toned negative prefix *té-*. The H of the negative prefix spreads right onto the stem in 'they will not call' (and is later delinked from word-initial position). The H of the negative prefix *tɔ́-* spreads even further into the stem in the Infinitive Negative forms in (18b), which take the µ4 melody.

(18) a. µ3 melody: Remote Future Negative 'they will not . . . '
(foc-3pl-tns-[root-fv] neg)
te̲-βá-ré-[βérekér-á] hai 'call'
te̲-βá-ré-[koondókór-á] hai 'uncover'

b. µ4 melody: Infinitive Negative 'to not . . . ' (aug-inf-neg-inf-[root-fv])
o-ɣo-tɔ̲́-kó-[βéréker-á] 'call'
o-ɣo-tɔ̲́-ɣó-[káraaŋg̲-á] 'fry'
o-ɣo-tɔ̲́-kó-[héétok-á] 'remember'
o-ɣo-tɔ̲́-ɣó-[kóóndokór-a] 'uncover'

The extent of rightward spreading of the H of the negative prefixes in the two tenses in (18) depends on the position of the melodic H. The melodic H is therefore already in place before the H of the prefix spreads.[16] If the melodic H reached its position by LLH and LLLH melodies, a number of formal problems would follow since spreading would have to ignore the Ls: the Ls would neither block spreading nor play any role in limiting the rightward extent of the H-toned prefix, as we would expect if L were phonologically active (see Hyman 2001). This would require deleting each L (or removing association lines one by one from a single, multiply linked L) as part of the iterative spreading process. The spreading rule therefore would perform multiple

[15] We set aside the potential criticism that LLH and LLLH are not possible melodies, as they violate the OCP (see Odden 1986 for discussion).

[16] Following Spread, an additional delinking rule is required in cases such as *o-ɣo-tɔ́-ɣó-[káraaŋg̲-á]* 'to not fry' where the H of the prefix that is associated to the first mora of a long vowel is delinked from that mora, such that the entire syllable before the melodic H is L.

operations that could not be stated as separate ordered rules. This is formally problematic, as multiple operations are generally thought to not to be possible in a single phonological rule (Calabrese 2005:119; Clements and Hume 1995:250).

There is little need to posit phonological Ls in Kuria, and in our view the ability of Hs to be assigned to positions far inside the stem and to spread considerable distances in the phrase is a consequence of the underlying tonelessness of moras in the Kuria verb. The only known potential evidence for L concerns the representation of word-final rising tones in examples like *to-ra-*[*sukur-ă*] 'we are about to rub' from (11) above. However, these LH sequences are derived after the insertion of L through the late rule of Default L Insertion, and as noted in footnote 14, it may be that these forms have a phonologically long vowel, which leaves open the possibility of a ØH representation of the final rising tone.

3.2 A metrical approach

A second alternative to counting is a metrical solution, in which the melodic H is not assigned directly to the third or the fourth mora of the stem but indirectly by creating metrical structure and then linking the melodic H to a metrically prominent position (see, e.g., de Lacy 2002). Hyman (1989) notes two possible metrical solutions to target the fourth mora, based on Odden's (1987) analysis of the Nyabaasi Kuria tone patterns: (i) H is attracted to the head of a right-headed moraic colon at the left edge of the stem (Hammond 1987): {(μμ)(μμ̆)}, or (ii) the stem-initial foot is extrametrical, and H is attracted to the head of a right-headed moraic foot at the left edge of the stem: <(μμ)>(μμ̆).

A metrical solution is attractive because it provides a solution to the locality and 'counting' problems encountered by our analysis. However, one property of the metrical approach that may be considered a drawback is that the same verb stem would have at least four different metrical parses depending on the tense, since there are μ1, μ2, and μ3 melodies in addition to μ4. As we will see below, there are some verbal constructions with both μ1 and μ4 melodies, which would require independent, conflicting metrical structures to position each melodic H within a single word.[17]

3.3 Prosodic infixation

An additional analytical possibility, suggested to us by Chris Collins, is that some melodic Hs could be infixed inside the stem (see, e.g., Samuels 2010, 2011; Yu 2007). The melodic H for each tone pattern would be an affix that attaches to a prosodic constituent at the edge of the stem. The μ1 melodic H would be a prefix and would link to the first stem mora; the μ2 melodic H would be infixed after the first stem

[17] A reviewer suggests an additional possible problem for a metrical analysis: there apparently do not exist any stress systems in the world's languages that target the fourth syllable from an edge—a generalization noted recently by Heinz (2009:310). If "the head of a right-headed moraic colon at the left edge of the stem" is a position that can be targeted in the metrical phonology of a language, one might expect that some stress system would make reference to it. While we agree with the referee's ultimate conclusion, we do not feel that this is the strongest argument for our position, as the lack of languages with stress on the fourth syllable could be an accidental gap (see Sect. 5 for further discussion).

mora; and the μ3 melodic H would be infixed after the first foot. The benefit of this approach is that it avoids the problems caused by the L tones in the melodic approach discussed in Sect. 3.1, and it also avoids the drawbacks of conflicting metrical parses discussed in Sect. 3.2. One potential problem, however, is that the μ4 melodic H would have to be affixed to a ternary foot, whereas the foot parsing for the other melodic H tones would be binary. It is not clear that the advantages of the prosodic infixation approach would make it worthwhile to add such a layer of complexity to the metrical analysis of the language.

4 Is tone different?

As Hyman (2011) notes, it is not uncommon for phonologists to entertain the possibility that tone is different from segmental and metrical phonology. For example, perhaps the presence of multiple elements in a rule trigger is allowed for tone rules but not for segmental rules. If tone rules have fewer restrictions on them, we might expect that they apply separately from segmental rules. Indeed, the striking phrasal level tonal properties of Kuria led to a discussion following an oral presentation of this paper as to whether the tonal rules of Kuria might apply after the rest of the phonological rules.[18] In this final substantive section, we demonstrate that this is not the case for Kuria, as non-tonal phonological rules are interleaved with tonal rules.

The data in (19a–b) show 3rd person forms in the Inceptive tense, which have the μ4 melody discussed above as well as the μ1 melody, which is conditioned in this tense by the 3rd person subject prefix. We see in these forms that C-initial and V-initial stems have the same tonal pattern after the tense prefix *ra-*, which has a short vowel: the μ1 melodic H begins on the stem-initial mora in both contexts. (19c) shows that the μ1 melodic H spreads one mora to the right; further spreading is blocked by the presence of the μ4 melodic H.

(19) μ1 and μ4 melodies: Inceptive 3p. 'they are about to…'

a.	βa-ra-[ká̲raaŋg-á̲]	'fry'
b.	βa-ra-[íɣɔɔmb-á̲]	'desire'
c.	βa-ra-[βé̲réker-á̲]	'call'

The data in (20) show a different verb form with the μ1 and μ4 tonal melodies, 3rd person forms from the Immediate Past Anterior, which differ structurally from those in (19) in that there is a long vowel immediately preceding the stem, due to the onsetless tense prefix *a-*. In C-initial forms in (20a), the expected μ1 and μ4 tonal patterns appear. In the forms with a V-initial stem in (20b), however, we see that the melodic H begins on the second mora of the stem.

(20) μ1 and μ4 melodies: Immediate Past Anterior (3p.) 'they have just …ed'

a.	βa-a-[ká̲raaŋg-é̲re]		'fry'
	βa-a-[βé̲réke-é̲ye]		'call'
b.	βa-i[ɣóómb-é̲re]	</iɣoomb/	'desire'
	βa-a[néké-é̲ye]	</aneker/	'lay out'

[18] Thanks to Greg Iverson for raising this question.

One interpretation of these forms is that the stem-initial mora counts in the calculation of the μ4 melody but does not count in the calculation of the μ1 melody, due to the fact that a rule deleting the stem-initial mora follows the rule of μ4 H Tone Association but precedes the rule of μ1 H Tone Association. On another analysis, suggested by an anonymous reviewer, the melodic Hs are first assigned to the first and fourth stem moras, followed by spreading, creating intermediate *βa-a-*[*íɣóomb-ére*]. Next, a process of vowel assimilation applies, producing *βa-i-*[*íɣóomb-ére*], and then deletion, yielding *βa-i*[*ɣóomb-ére*]. At this point, tone retraction, preventing a Fall-H sequence, would normally apply, but it does not apply here because the retraction rule delinks the final association line of a multiply-linked H tone. However, since there is a total prohibition of Fall-H sequences, another rule applies that spreads the H to a following tautosyllabic mora, yielding the surface form *βa-i*[*ɣóómb-ére*].

We are unaware of specific arguments in favor of one derivation over the other, but under either alternative, the vowel hiatus-resolving rules are crucially interleaved among the tonal rules. We conclude that the tonal derivations of Kuria must be computed in tandem with the segmental derivations.

5 Conclusion

If one accepts the results of the study, showing that tonal grammars can count moras, one might still ask whether tone is special in its ability to count. Why do we not find segmental phonological rules that, for example, voice the third consonant of a verb? Our present hypothesis is that counting is formally permitted due to the fact that, as we propose, a 'trigger' may be made up of multiple phonological elements, which in the present case, are sequences of moras. However, counting is not widely attested because phonological rules so often arise historically from local phonetic effects, especially coarticulation. Even when phonetic effects are not strictly local, there are few situations that could point towards a counting analysis when a phonetic process is becoming 'phonologized'. However, the tonal representations of many African, and especially Bantu languages, can be quite unspecified. As a result, tones can be highly mobile (Hyman 2011; Yip 2002), and tonal alternations can take place at the phrasal level and over considerable phonological distances (Marlo 2013; Odden 1995). These properties of tonal systems may make the surface pitch patterns they generate more amenable to a counting-based reanalysis.

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