

Tonal alternations in attributive constructions in Mwaghavul

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Abstract. Mwaghavul is an underdocumented Chadic language spoken in Plateau State, Nigeria, by approximately 150,000 people (Blench 2011). Mwaghavul has tonal lowering in associative constructions, where the first nominal in the construction surfaces with low tone, regardless of its tone in isolation (Arokoyo & Fwangwar 2019). However, tonal lowering is not fully predictable, as some high tone nominals surface as mid tone in associative constructions, instead of low. Number of syllables, vowel length and quality are not consistent predictors, as there are minimal pairs for high tone alternations. We investigate the phonetics of these high tones, to determine whether two phonetically distinct high tones have been incorrectly documented as one, or whether one phonetic high tone has two phonological behaviours. The f₀ of 77 tokens in isolation and 561 tokens in associative constructions was extracted at 10 points using Prosody Pro (Xu 2013). In isolation, high tones that become mid in associative are visually distinct from those that become L, with approximately 15-20Hz difference throughout the tone duration. Linear mixed effects models confirm this difference is statistically significant. The presence of separate high and superhigh tones in Mwaghavul indicates that the phonetic implementation of the floating low tone is realized differently depending on the pitch of the original tone. This suggests that the original tone is not deleted, but rather dissociated and present, affecting the realization of the tonomorpheme in an unusual pattern that is not commonly attested.

Keywords. tonomorpheme, phonetics, phonology, Chadic languages, associative constructions

Introduction. Tone, the manipulation of pitch to create contrastive meaning (Yip 2002), may serve many functions in tonal languages. Hyman (2016) notes that there are two primary functions of tone, lexical and grammatical, and that languages vary with regards to the function of tone. For languages with grammatical tone, tone may be the exponent of a wide variety of syntactic and semantic processes. Tonomorphemes, or morphemes whose primary exponent is tone, are of particular interest to both phonologists and syntacticians, as they display behaviour that is uncommon in morphemes that consist of segmental material. Yip (2002) notes that tones may be ‘mobile’ in that they can surface farther away from their underlying location due to processes such as spreading, deletion, and replacement. Hyman (2016b) further establishes that tone is not limited to the same locality restrictions that segmental morphemes are. For example, a low tone may trigger processes such as downdrift or downstep, where high tones are realized with a lower f₀ (Yip 2002). Languages vary in the realization of this high tone, as downstep can cause a high tone noun to surface as mid in Bimoba (Snider 1998) but as low in Ebira (Adeniyi 2017). In

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this sense, phonetic realizations are constrained by language-specific conditions even though the phonological process is shared across unrelated languages. Conversely, upstep entails a high tone being realized with a higher f_0 when following a floating low tone (Yip 2002). The raising and lowering of high tones following a low tone is an example of contrast maximization or “dispersion theory”, where the f_0 is manipulated in such a way to emphasize the contrast between existing tones (Lindblom 1990, Flemming 1996, Yoshida 2011). Not all languages have the same triggers for contrast maximization. In Krachi, a Kwa language of Ghana, only floating low tones can trigger upstep, not linked low tones (Snider 1990, Yip 2002). This highlights the asymmetry of floating versus linked tones and its resultant effects on tonal realizations.

However, current documentation on tone in general is described as ‘quite poor’ (Rolle 2018: 3) due to a lack of overall descriptions of tonal systems from a wide range of languages. Moreover, many current descriptions of tonal processes are based on listener perceptions without accompanying phonetic analysis. Descriptions of downstep and upstep from the 1970s and 1980s rarely include pitch tracking, relying instead on listener’s and speaker’s impressions of the data to classify tonal processes (cf. upstep in Krachi in Snider 1990). While this work is important to provide a descriptive baseline, it does not account for potential phonetic variation that is not perceived as significant by the listener. For example, Ajíbóyè et al. (2011) find variation between syntactically and morphologically derived tone in Yorùbá, where the mean peak f_0 value of a syntactically derived mid tone is significantly lower than that of a morphologically derived mid tone. In this way, phonetic data can inform studies of the tonal inventory and account for how phonological processes interact and constrain phonetic realizations.

We investigate a phonological process commonly described in languages of West Africa, where tone is used to mark associative constructions (Cahill 2000). In these cases, the primary exponent of the associative marker is a floating tone, which may vary in its height depending on the language. For example, in the Chadic language Ga’anda, the associative marker is a floating high tone (Kenstowicz 1994), while in the Kru language Bété de Gbadi, the associative marker is a floating low tone (Charette 1982). Similar to the research established in Ajíbóyè et al. (2011), there may be previously undescribed variation across underived (i.e. lexical) tones and derived (from the associative tonomorpheme) tones. This variation may be key in accounting for otherwise ambiguous applications of the tonomorpheme in associative constructions. We extend the application of phonetic data to investigate the tonal alternations of associative constructions in Mwaghavul, a Chadic language of Nigeria. In this language, the first noun of an associative construction without a preposition surfaces with a low tone, regardless of its tone in isolation. While some high tones follow this same pattern and surface with a low tone, the high tone of other nouns invariably surfaces as mid rather than low in the same morphosyntactic context. To investigate the phonetic realization of the lexical tone and tonal alternation in the associative construction, we conducted an acoustic investigation. This work contributes to our understanding of autosegmental content and its implications for phonological processes by using laboratory phonetics as a primary source of evidence. Additionally, this work contributes to the documentation of Mwaghavul as the first phonetic description of the language’s tonal inventory, challenging previous assumptions that the language has three level tones (Poret & Punshak, 2023). It is also crucial to the study of upstep, which is underrepresented in linguistic literature.

1. Further details. This section presents a brief sound inventory of Mwaghavul that is relevant to this work. Mwaghavul is an underdocumented Chadic language spoken in Plateau State, Nigeria, by approximately 700,000 people (Barnabas 2011, Blench 2011, Fwangwar 2018). Data primarily comes from Arokoyo and Fwangwar (2019), which provides an autosegmental account

of these tonal processes, and supplemented with elicited data from the fourth author, who is a native-speaker linguist and is the second author of Arokoyo and Fwangwar (2019).

The basic syllable structure in Mwaghavul is CV(:)(C), where the diacritic indicates lengthening. Examples of all possible syllable types are presented in (1). Although all examples are presented with low tones, there are no attested co-occurrence restrictions on syllable shape and tone. In Mwaghavul, commonly attested tone-bearing units (TBUs) are vowels, although there are cases where nasals can pattern as TBUs and be the head of a syllable.

- (1) Syllables in Mwaghavul
- | | | |
|------|------------------|------------|
| CV | k ^w è | ‘chicken’ |
| CCV | pò: | ‘mouth’ |
| CVC | màt | ‘woman’ |
| CVVC | bè:n | ‘gallon’ |
| NCV | ṛ.gā | ‘adultery’ |

The consonant inventory of the language is presented in Table 1, reproduced with modifications from Fwangwar (2018).

	Bilabial	Labio-dental	Alveolar	Palatal	Velar	Labial-velar	Glottal
Plosive	p b		t d		k g		ʔ
Implosive	ɓ		ɗ				
Nasal	m		n	ɲ	ŋ		
Fricative		f v	s z	ʃ ʒ	χ		h
Affricate				tʃ dʒ			
Approximant				y		w	
Trill			r				
Lateral approximant			l				

Table 1. Consonant Inventory of Mwaghavul

There are six phonemic vowels, each with a long counterpart. The full set of vowels is presented in Table 2 from Fwangwar (2018). There do not appear to be any restrictions on which vowel qualities can occur with different syllable types.

	Front	Central	Back
High	i i:	ɨ ɨ:	u u:
Mid	ɛ ɛ:		ɔ ɔ:
Low		a a:	

Table 2. Phonemic Vowels of Mwaghavul

Lastly, previous studies identify four contrastive tones in Mwaghavul: High, Mid, Low, and Rising (Low to High) (Arokoyo & Fwangwar 2019, Poret & Punshak 2023). The tone contrast is illustrated with the minimal set in (2). There do not appear to be any restrictions based on vowel quality, length, or syllable type (open vs. closed) for each tone. Tone-bearing units (TBUs) may be vowels or nasals, although nasal TBUs frequently carry a low tone. Since both vowels and nasals are mora-bearing units, we conclude the mora is the tone-bearing unit in Mwaghavul.

- (2) Tones in Mwaghavul
- | | | |
|---|-----|---------------|
| H | ká: | ‘head’ |
| M | kā: | ‘like’ |
| L | kà: | ‘germinate’ |
| R | kǎ: | ‘grandmother’ |

2. Nominal modification. In this section, we turn to the main focus of this work, which is two patterns of tonal alternation in the context of associative constructions. There are two strategies for associative constructions in Mwaghavul. The first strategy, which involves tonal alternation, is described in Section 2.1, and the second strategy, which has an overt preposition, is presented in Section 2.2.

2.1. TONAL ALTERNATIONS. The first pattern of associative constructions in Mwaghavul is formed by two nouns in a sequence with the interpretation “Noun of Noun.” The first noun (N₁) undergoes tonal alternation. In this case, there are two options for tonal alternations: the first nominal may either surface as a mid or low tone. However, the second nominal never exhibits alternations in its tone melody. Nominals with a mid, low, or rising tone consistently surface as low tone. Nouns with high tone follow one of two patterns. The first pattern will be categorized as Pattern A, as shown in Table 3. Here, the first nominal with high tone surfaces as a low-tone noun. This pattern is consistent for a given lexical item N₁ regardless of the syllable number (one versus two) of either the N₁ or N₂ and the tone of the following noun (high, mid, low, or rising).

	N ₁	N ₂	N ₁ N ₂	Translation
H + H	lú	kóm	lù kóm	‘house of groundnut’
H + M	lú	wān	lù wān	‘house of clay’
H + L	lú	lèk	lù lèk	‘house of fighting’
H + R	lú	ǫǫǫ	lù ǫǫǫ	‘house of river’
H + HH	lú	ǫǫǫǫ	lù ǫǫǫǫ	‘house of snow’

Table 3. N₁ with High Tone: Pattern A

The second pattern is Pattern B, presented in Table 4, where the first nominal with high tone surfaces as a mid rather than low tone. This pattern is also consistent for a given lexical item N₁ across the number of syllables for either the N₁ or N₂ or the tone of the following nominal (high, mid, low or rising). Similar to the pattern in Table 3, surfacing as a mid tone may occur in nominals with either open or closed syllables, as well with either short or long vowels.

	N ₁	N ₂	N ₁ N ₂	Translation
H + H	lé:	kóm	lē: kóm	‘clothes of groundnut’
H + M	lé:	wān	lē: wān	‘clothes of clay’
H + L	lé:	lèk	lē: lèk	‘clothes of fighting’
H + R	lé:	ǫǫǫ	lē: ǫǫǫ	‘clothes of river’
H + HH	lé:	ǫǫǫǫ	lē: ǫǫǫǫ	‘clothes of snow’

Table 4. N₁ with High Tone: Pattern B

There is evidence of minimal pairs between Pattern A and Pattern B presented in Table 5, where high tone nouns with identical segmental content can pattern differently in associative constructions.

N ₁	N ₂	N ₁ N ₂	Translation
ḡwó:n	nìyìn là:	ḡwò:n nìyìn là:	‘pelvis of goat/sheep’
ḡwó:n	lú	ḡwō:n lú	‘surroundings of house’
tó:k	rē:p	tò:k rē:p	‘neck of sheep’
tó:k	má:r	tō:k má:r	‘subdivision of farm’

Table 5. High Tone Minimal Pairs in Associative Constructions

As mentioned earlier, the first nominal consistently surfaces with a low tone when it has a mid, low, or rising tone in isolation. This pattern is consistent across the number of syllables and the tone of the following nominal. A selection of data for the other tones in nominal construction is presented in Table 6.

	N ₁	N ₂	N ₁ N ₂	Translation
M + H	wān	lú	wàn lú	‘clay of house’
L + H	lèk	lú	lèk lú	‘water of house’
R + H	džěp	kóm	džěp kóm	‘children of groundnut’

Table 6. N₁ with Mid, Low, and Rising Tone in Associative Constructions

To understand the structure of the tonal alternation, it is important to compare it to the second strategy of associative construction in Mwaghavul. In the next section, we describe the second strategy, which involves the use of a preposition instead of a tonal alternation.

2.2. PREPOSITION. Associative constructions may also be formed with the preposition *mù* ‘of’. When this preposition occurs in between two nouns, there is no tonal alternation of any element. In these cases, the tone of the first nominal is invariant. This pattern is consistent across both monosyllabic and bisyllabic nominals in N₁ position, with an example shown in (3). While the two constructions are largely equivalent, the construction with tone lowering is the default interpretation and the version with the overt preposition is used as emphasis or focus. In cases where an associative construction constitutes an idiomatic meaning, the construction with the preposition also encodes the idiomatic interpretation.

- (3) a. Monosyllabic¹
bǝŋ mù kú:l
farm PREP garden egg
‘farm of garden egg’ (Arokoyo & Fwangwar 2019: 41)
- b. Bisyllabic
jã̀yàl mù ʃĩrēm
money PREP seedling
‘money of seedling’ (Arokoyo & Fwangwar 2019: 43)

Similar to the associative construction linked with the preposition *mù*, the genitive marker *kì* does not involve any tonal alternation. The genitive marker *kì* is a separate lexical entry from both variants of the associative marker, as it has separate semantic attributes and is phonologically distinct from either form. While idioms retain their idiomatic reading with either the tonomorpheme or the preposition *mù*, the genitive marker *kì* consistently derives the literal meaning, as presented in (4).

¹ Abbreviations used in glosses are GEN = genitive and PREP = preposition.

- (4) a. Preposition
 lú mù wát
 house PREP thief
 ‘stolen house’
- b. Genitive Marking
 lú kì wát
 house GEN thief
 ‘thief’s house’ (Arokoyo & Fwangwar 2019: 45)

2.3. PREVIOUS RESEARCH AND QUESTIONS. To summarize, associative constructions in Mwaghavul pattern as follows: The first nominal in an associative construction undergoes tonal alternations when it occurs without a preposition or genitive marker. Some high tone nouns surface with a mid tone on their TBU(s) when they occur as the N1 in associative constructions that do not have the preposition, while other high tone nouns surface with a low tone in the same context. Nouns with mid, low, or rising tone invariably surface with a low tone when they are in the N1 in an associative construction without the preposition.

The associative marker that triggers this tonal alternation is proposed to be a floating low tone that causes reassociation and tonal simplification (Arokoyo & Fwangwar 2019). Under the larger typology established by Rolle (2018), the associative morpheme is an independent prosodic exponents, where the grammatical category is established by a morpheme that is expressed only by autosegmental content, namely a floating low tone. Arokoyo and Fwangwar (2019) propose a similar analysis, where the exponent of the associative marker is a floating low tone that usurps every TBU of the first nominal in the associative construction. Based on the schema described in previous research, the realization of the grammatical tone also forces the deletion of the lexical tone. In cases where the first nominal is multisyllabic, they propose that the associative morpheme docks to the rightmost syllable, which then triggers cycles of simplification and spreading until all syllables have been re-associated with the associative marker (Arokoyo & Fwangwar 2019).

Arokoyo & Fwangwar (2019) analyze the associative marker as a floating low tone that attaches to the rightmost syllable of the first nominal. The lexical and grammatical tones on the rightmost syllable of the first noun are then resolved through tonal simplification, where the original underlying tone is deleted and only the low tone from the associative tonomorpheme is retained. However, there is no motivation given for their tone-deletion account. Specifically, they do not consider the possibility that the replaced lexical tone may float, instead of being deleted, an attested phenomenon across languages (Pike 1948, Lionnet et al. 2022).

A second issue is the discussion of the lexical high tone surfacing as either low or mid tone in associative constructions. To account for the high tone alternations, Arokoyo & Fwangwar (2019) propose that the newly docked L tone and the pre-existing H tone simplify and are realized as a single M tone. They note that the floating low tone, i.e. the associative marker, may cause different degrees of tonal lowering on high tone nouns. This analysis raises the issue of why the tonal overwrite of the high tone in other words does not also result in a mid tone emerging from a high-low merger; instead, a complete overwrite occurs. In order to account for their claim that the replaced lexical tones are deleted, this process must also include lexical specification, where different lexical items trigger specific phonological processes.

If lexical specification determines whether a noun surfaces with low or mid as the N₁ of an associative construction, there would need to be two forms of the associative linker: one with a floating mid and another with a floating low tone. Under the assumption that the nominal classification is not phonologically conditioned in its realization, the prediction therefore is that nouns with low, mid, and rising tones could also surface as mid when they occur as the N₁ of an associative construction. However, the reality of tonal alternation in the language does not

support this noun-class analysis. To truly understand the motivation for the alternation of lexical high tone as mid or low in the associative construction, we need to understand whether the lexical tones are deleted or float when they are replaced with the low-tone exponent of the associative marker. Thus, the important question to ask is whether the overwritten lexical tones have any effect on the realization of the grammatical tone. If the answer to this question is yes, it is also crucial to know whether these effects can be traced to acoustic properties of the lexical tone in isolation or in the associative construction. In other words, are there two phonetically distinct high tones or a single high tone with two phonological realizations in the language? To answer these questions and account for the tonal alternation of high tones in the associative construction, we conducted a phonetic investigation. The details of the phonetic investigation are presented in the next section.

3. Phonetic realizations. Recordings were conducted in a quiet environment with a Zoom Q8n-4K audiovisual recorder with a Shure SM35 headset condenser microphone at a sampling rate of 48kHz with 16 bits. The participant was visually presented with the stimuli in English and then asked to provide a translation in Mwaghavul. A total of 561 tokens in associative constructions and 77 tokens in isolation were produced by the fourth author, a native speaker of Mwaghavul, who was 41 years old at the time of the study and additionally speaks Hausa, Nigerian English, and Naija (Nigerian Pidgin). The data were collected in Ibadan, Nigeria in an elicitation session facilitated by a research assistant, Olayinka Oluwagbemiga Babatunde, who is a linguistics student at the Department of Linguistics, University of Ibadan.

A list of monosyllabic words that covered all the previously posited tones in the language was compiled. The monosyllabic words with high tone are grouped based on whether they surface as mid or low in the associative construction. The stimuli contains both long and short vowels, as well as open and closed syllables. Vowel and consonant quality were not controlled for. Each word was repeated four times. There were only three words (là: ‘child,’ dà:m ‘bag,’ and kwè ‘chicken’) collected in isolation for low tone nominals instead of four, but all four nominals were collected in associative constructions.

For the associative constructions, each of the target tokens was elicited in front of one of seven nominals. These stimuli are controlled for tone and syllable structure (each monosyllabic noun is CVC and each bisyllabic noun is CV.CVC). Each construction was repeated four times. No associative constructions with the preposition or genitive marker were elicited. Tokens were first annotated in Elan (Wittenburg et al. 2006) by a research assistant and then vowels were manually annotated in Praat (Boersma & Weenink 2024). Pitch was extracted at ten points to track contours using Prosody Pro (Xu 2013). Tokens shorter than 10ms were discarded due to a lack of appropriate points to extract pitch from. A distribution of the remaining tokens is presented in Table 7.

Lexical Tone	Associative	Isolation	Total
H → L	109	16	128
H → M	112	17	126
M	112	16	128
L	116	12	128
R	112	16	128

Table 7. Distribution of Tones Separated by Lexical Tone and Task

A plot of the pitch contours by lexical tone is presented in Figure 1, with tones derived from the associative (Assoc) construction on the left and tones from the tokens in isolation (Iso) on the right. In these graphs, the tone in isolation is on the left and the tone in the associative construction is given on the right. For example, the high tone that becomes low in associative constructions is labelled as “H_L,” the high tone that becomes mid is labelled as “H_M.”

For the tones derived from associative contexts, there appear to be two main tones, although there is some variation in the low tones derived from mid tone nouns and high tone nouns that become low in associative constructions. Those two tones are slightly higher than the other two low tones, which come from tokens that are underlyingly low or rising. There is a 10Hz gap at the onset between the H_M and the M_L tone in associative constructions, and the grammatical low tones become progressively lower throughout the duration of the vowel (with the exception of the lexical H_L tone). Across the entire duration for tones in associative construction, there is generally a 10-20Hz difference between the grammatical mid tone and the grammatical low tones, which is similar to the difference between the high tone that surfaces as mid and the high tone that surfaces as low.

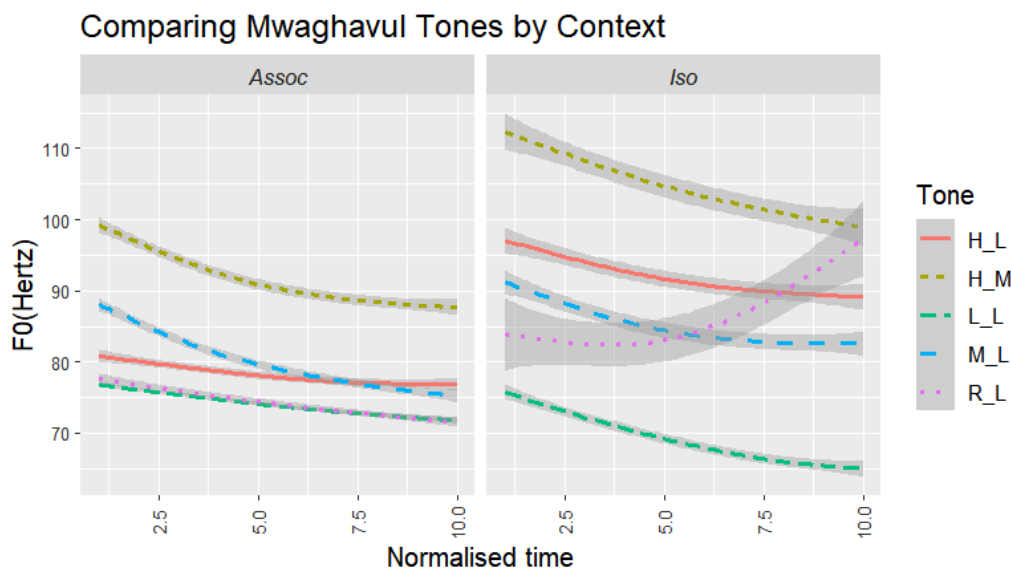


Figure 1. Mwaghavul Lexical Tones in Isolation and Associative Constructions

There are five distinct tones identifiable in isolation in Figure 1. The H_M tone starts at a height of around 115 Hz and lowers to around 100 Hz. The H_L tone begins at 100 Hz and ends around 90 Hz. The M_L tone begins slightly lower than the second high tone at around 95 Hz and ends at around 75 Hz. The R_L tone begins around 85 Hz and reaches a peak of around 100 Hz, close to height of the highest tone. The R_L tone also has a higher margin of error compared to other tones, likely due to the larger trajectory change of the tone. Lastly, the L_L tone begins at around 70 Hz and ends at around 50 Hz. Overall, the derived low tones in the associative constructions show variation in the height of their onset and their overall contour throughout the construction compared to the lexical low tone. However, none of the tones in associative constructions exactly match the low tone in isolation.

To compare, Figure 2 presents each tone’s realizations in associative constructions and in isolation. Each tone is labelled with its tone in isolation as the first letter and its tone in associative constructions as the second letter. The H_L, H_M, and R_L tones all show a lower tone in associative constructions than they do in isolation, for an average of 20Hz at the point of greatest

difference throughout the duration. The M_L tone does not show a large difference across the realization of the TBU, and the L_L tone is realized as higher in associative constructions than it is in isolation.

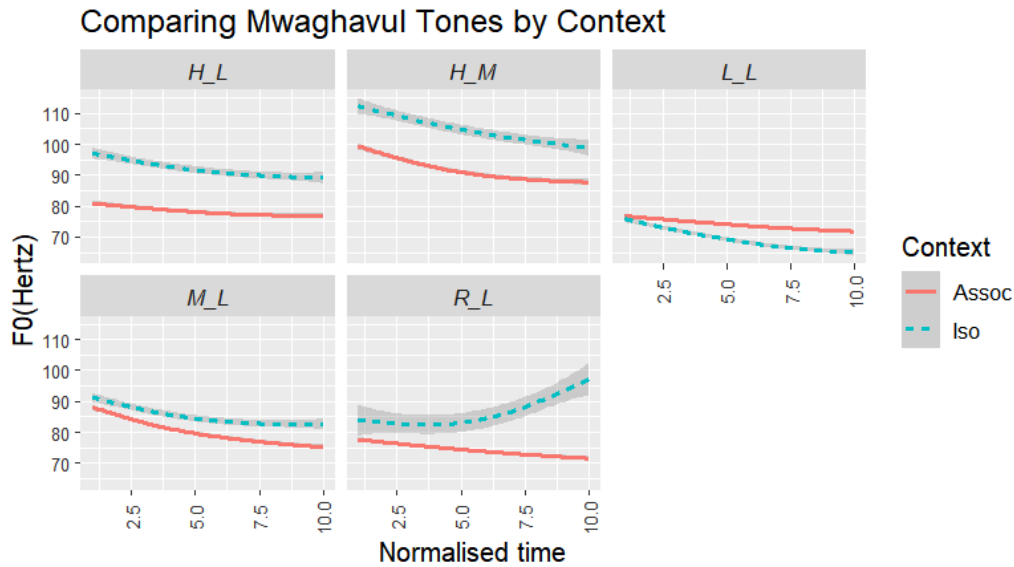


Figure 2. Mwaghavul Tones separated by Lexical Tone and Morphophonological Context

Figure 3 presents just the two high tones beside one another in both associative constructions and in isolation. Similar to the plot of tones presented in Figure 3, there is approximately a 10Hz difference at all points of the tone contour, both in isolation and in associative constructions. This difference suggests that there are two distinct high tones in Mwaghavul rather than one high tone that has two phonological patterns.

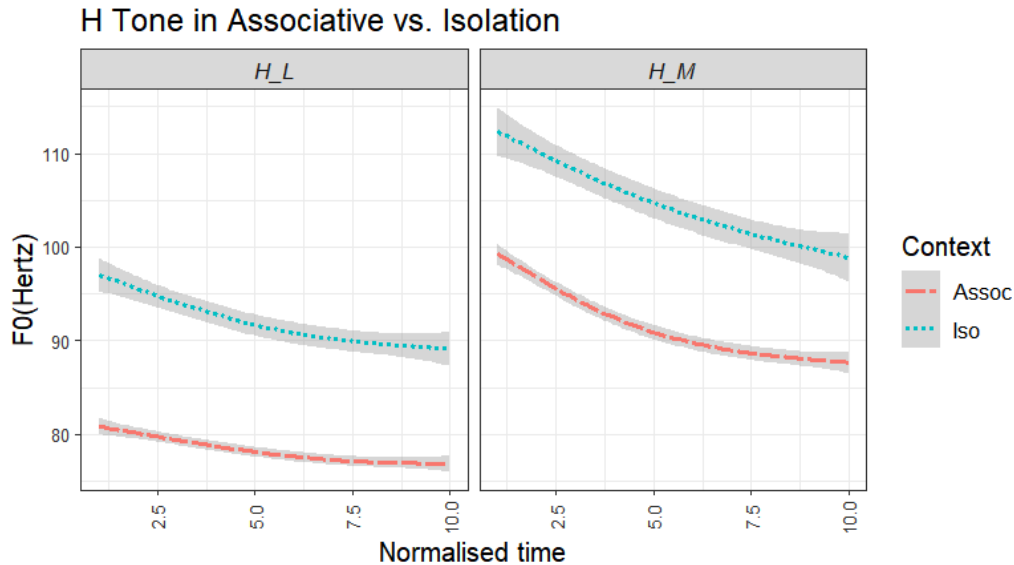


Figure 3. Mwaghavul Tones separated by Lexical Tone and Morphophonological Context

These two high tones appear visually distinct in the two graphs. However, models of statistical significance are required to confirm whether this distance between the two tones is indicative of two separate tones or whether it can be attributed to variation. To investigate this, linear mixed models were run in R with the f0 of each vowel in isolation at each measured interval (25, 50, or

75) and tone as the fixed effect and word as a random intercept in R (R Core Team 2024) using the lme4 package (Bates et al. 2015). The H_M tone is significantly different from the H_L tone at every interval ($p < 0.05$). At each interval, there is approximately a 10-13Hz difference between each of the two high tones. These results confirm that there are two separate high tones that are acoustically different.

Next, linear mixed effects models were run on f0 in the derived tones in associative constructions, using the same lme4 package in R (Bates et al. 2015), with tone as a fixed effect and word as a random effect, to see if there are significant differences in the derived tones (R Core Team 2024). The reference level is the H_L, which has a high tone in isolation and a low tone in associative constructions. At the 25% interval, all derived tones except the M_L tone are significantly lower than the H_L intercept, while at the 50% interval, only the H_M and L_L tones are significantly different from the derived H_L tone ($p < .$). Lastly, at the 75% interval, all derived tones are significantly different from the H_L tone, with the exception of the R_L tone. These significant differences across the tonal contour point to variation in the realization of tonal lowering, suggesting gradient effects rather than categorical lowering to an L tonomorpheme.

4. Discussion. Based on the evidence presented in Section (4), the tonal inventory of Mwaghavul consists of the following tones: superhigh, high, mid, low, and rising. Instead of one high tone with two phonological patterns, there are two distinct high tones: one superhigh and one high. The presence of a superhigh tone is attested in other languages, such as Ebira (Rolle 2022) and Guébie (Sande 2022). Unlike some cases where superhighs are derived and lack phonemic status (such as in Ebira), the two high tones of Mwaghavul are phonemically distinct, similar to the case in Guébie, which is further evidenced by the minimal pairs presented in Table 5. Rather than one high tone with two phonological patterns, there are two different high tones with different respective phonological alternations. Therefore, there is not a phonetics/phonology mismatch, as there are two phonetically distinct high tones. However, the presence of two high tones does not resolve the larger question: Why is only the superhigh tone realized differently in associative constructions?

Acoustic evidence shows that in associative constructions, the superhigh tone is realized as a mid tone and the high is realized as a low tone. The trigger of this alternation is a floating low tone that is the exponent of the associative linker, as the tone lowering in the first nominal in the associative construction varies based on the lexical tone of the target nominal. However, the outcome for the replaced lexical tone is one of three proposed options: deletion, merger (as proposed by Arokoyo & Fwangwar 2019), or floating lexical tone. The acoustic investigation allows us to investigate the three processes and see which are supported by phonetic evidence.

The first hypothesis is that the lexical tone is deleted and the grammatical tone overwrites the tonal melody of the first nominal. In order for this account to correctly predict when one tone melody is used over another, there should be a rule or pattern that predicts one over the other. Only the presence or absence of an underlying superhigh tone can predict when one tonomorph is used or not. Under this account, one of the two elements (either the associative markers or the nominals) themselves should be lexically specified. However, lexical specification does not explain why derived low tones have a higher f0 than underlying low tones, as shown in Figure 3. Instead, it is more likely that tonal lowering is not equally applied in all contexts or that it shows variation in its realization depending on predictable factors. It may also be the case that lexical and grammatical tone are distinct, comparable to the realisation of lexical and morphosyntactic tone in Yoruba (Ajíbóyè et al. 2011). In this case, it is not unexpected that there is not a one-to-one mapping between the lexical low tone and the grammatical low tone.

The second hypothesis, as proposed by Arokoyo & Fwangwar (2019), is that the lexical tones merge with the grammatical tone. This analysis supposes that there is a merger account only for the superhigh tone that surfaces as mid tone, but instead assumes there is a deletion process for all other tones in the system. There is no phonetic naturalness account to motivate the retention of the superhigh tone but not any of the other tones in the inventory.

Instead, we modify this analysis to account for all tonal alternations in the inventory, where the tonomorpheme is present in the input as an undocked tone, which then causes upstep of the tonal melody of the nominal. In this work, we use a general definition of upstep, where a floating tone may cause a linked tone to be realized as higher (but not necessarily as a high tone). This analysis is based on the patterning of tone in Kabiye (Mabia) and Hausa (Chadic) nouns, where the tone melody on trimoraic nouns is a combination of its underlying tones (Roberts 2016, Newman 1986). Similarly, the associative marker in Mwaghavul has a surface realization where the degree of upstep is dependent on the lexical tone melody. The analysis is that each of the tones in isolation trigger tonal lowering in the associative construction but to varying degrees, accounting for the variation found in the derived tones. Given that the superhigh tone is the highest in isolation, its derived tone is also the highest. This higher realization can be interpreted as a form of upstep for the floating low tone. However, for lexical low tones, there is a smaller degree of upstep when in associative constructions.

For the underlying tones to affect the degree of tonal lowering, they must be de-associated but floating in the output. This analysis takes a gradient approach to tonal lowering but does not attribute the variation in tonal realizations to an inherent property of the tonomorpheme itself. Instead, the lexical tone interacts with the exponent of the associative marker to form a tone melody. Since the superhigh is significantly higher than the rest of the tones in the inventory, its realization in associative constructions is higher than the derived tones from other lexical tones (high, mid, low and rising). Crucially, we propose that the underlying tone is de-associated and floating but not deleted. A deletion or simplification analysis would need additional steps in order to correctly predict either the mid or low tone surfacing in a high-tone nominal associative construction.

This account makes the prediction in Figure 4, where the first step of the derivation has the lexical high tone underlyingly linked to the nominal, and the associative marker is a floating low tone that is present at the left edge of the second nominal. Next, the associative marker causes de-association of the lexical high tone and re-association with the floating low tone to the first nominal. The tonal melody is formed at this step, which becomes a combination of the floating high tone and the newly attached low tone. The floating high tone is not high enough to trigger upstep, so the surface representation of the tone is interpreted by speakers as being a low tone. However, there is variation in the actual f0 of derived low tones depending on the floating lexical tones.

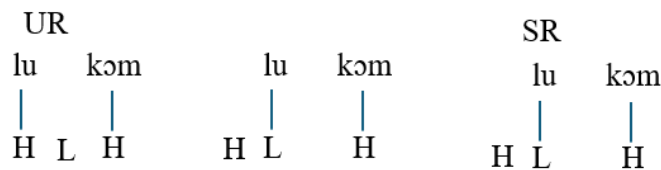


Figure 4. High Tone in Associative Constructions

A schema of the process for the superhigh tone is given in Figure 5. The process is identical to the one in Figure 4, where the lexical tone is de-linked and the floating low tone is associated with the nominal. However, the ultimate derived tone melody is closer to a mid tone than a low tone. The floating superhigh tone causes the final tone to be realized as a mid tone through up-step.

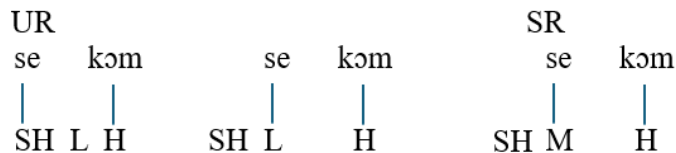


Figure 5. Superhigh Tone in Associative Constructions

Under the larger typology established by Rolle (2018), the associative morpheme is a replacive-dominant grammatical tone, where the underlying tone of the target is replaced by the new grammatical tone. We expand on this definition by proposing that underlying tones of the target may be undocked and unvalued, but still present in the input.

This account also makes the correct predictions for multi-syllabic nouns or nouns with differing tone patterns. In this case, the floating low tone causes de-association of all underlying tones and linking of the low tone to the rightmost syllable in the nominal. After the tone melody has been calculated, it spreads to all syllables in the first nominal, creating a consistent tone pattern. This account would also predict that there will be variation in the realization of low tones based on the underlying tones of the original multi-syllabic nominal. In order to fully test this hypothesis, different types of multi-syllabic nouns should be elicited to see which syllables can affect the overall tonal melody. Based on this account, we predict that upstep will occur only on the syllable that has the lexical superhigh tone, but not spread to other syllables.

However, the presence of the superhigh tone leads to the question about whether the tokens could have affected the elicited tones. Since consonant quality was not controlled, it is possible that the presence of voiceless consonants could have raised the f_0 of the superhigh nominals, causing them to be realized as superhigh (Kingston 2007). Moreover, the intrinsic f_0 of the vowels could have additionally altered the f_0 of the nominals (Whalen & Levitt 1995). We maintain that the presence of a superhigh tone is not strictly predictable based on the consonant or vowel quality of the nominal. Firstly, there are superhigh tokens that occur with voiced sonorants, namely the lateral liquid /l/ and the implosive /ɓ/.² Tokens of the superhigh tone with voiced obstruents should be collected to investigate whether there is a co-occurrence restriction on consonant type and tone. If there are no tokens of superhigh with a voiced obstruent onset, this suggests that the limited distribution of superhigh could be an indication of ongoing tonogenesis in Mwaghavul. Secondly, the presence of minimal pairs in the language suggests that the voicing of the consonant is not a consistent predictor of superhigh versus high tone. A perceptual experiment with these minimal pairs would show how speakers conceptualize and classify the superhigh tone compared to the high tone. If speakers are internally consistent but have varied results compared to one another, this would point to a change in progress where the superhigh tone shows high amounts of individual variation. In contrast, if speakers are internally inconsistent and show variation across all participants, this would suggest that the presence of the

² Based on the phonology of Mwaghavul, it is unclear whether the implosive patterns like a sonorant or like an obstruent, as both options are possible (cf. Sande & Oakley 2023).

superhigh tone is strictly due to phonological conditioning and is not part of the tonal inventory of Mwaghavul.

This research also expands on conceptualizations of lexical versus grammatical tone. Previous accounts focus on the distribution of lexical and grammatical tone (Hyman 2016a, Rolle 2018, Lionnet et al. 2022), as well as the functional load of each category of tone (Grimm 2022). Evidence from speech language pathology suggests that lexical and grammatical tone are processed differently (Tsiwah et al. 2024), and this research provides accompanying evidence that lexical and grammatical tones differ in their realizations, even if they are considered to be similar by speakers. Work on Yorùbá shows that mid tones that are lexically specified, syntactically derived, and morphologically derived surface with different f_0 values (Ajíbóyè et al. 2011). Similarly, Mwaghavul tones show variation in how they are realized in isolation (lexical tone) versus as derived (grammatical tone). While previous research based on speaker perceptions classified the primary grammatical tone in associative constructions as low (Arokoyo & Fwangwar 2019), phonetic research and statistical models reveal that there are significantly different realizations of “low” tone. Rather than having one consistent low tone, there appear to be four different tones that are lower than lexical mid tone but higher than lexical low tone. While models confirm that these tones significantly differ, it is unclear how speakers may categorize these variations in tone. Perceptual studies can expand upon this finding by investigating how Mwaghavul speakers classify grammatical versus lexical tones to find the range of what is considered a “low” versus “non-low” tone, either on nonce words or with minimal pairs.

5. Conclusion. Previous documentation proposes two separate high tone patterns for associative constructions in Mwaghavul, where one high tone surfaces as a mid tone and one high tone surfaces as a low tone (Arokoyo & Fwangwar 2019). All other attested tonal melodies surface as low tone when they are the first nominal in associative constructions. This phonetic investigation reveals that there are two distinct high tones in Mwaghavul, where one is significantly higher than the other. This superhigh tone consistently surfaces as a mid tone rather than a low tone.

To account for this alternation, we propose modifications to Arokoyo & Fwangwar’s (2019) previous analysis, where instead of being deleted, the underlying tone of the nominal is undocked and floating. The associative marker does not fully replace the lexical tonal melody; instead, the final tone melody is a combination of the underlying tone (which is present in the input but not associated with any TBU) and the exponence of the associative marker (a floating low tone). This melody is affected by the presence of a floating superhigh tone, which triggers upstep on the nominal and causes the grammatical low tone to be realized as a mid tone. This proposal accounts for both the binary variation between the derived low and mid tone, but additionally makes the correct predictions for the additional variation between derived low tones in the output. This research adds to Rolle (2018)’s typology of dissociative versus replacive grammatical tonal processes, adding a third category, where tones are undocked but retained in the input.

Further research is needed to investigate the prevalence of the superhigh tone across multiple speakers where consonant and vowel quality of the stimuli are controlled, as well as perceptual studies to see how speakers categorize the superhigh tone compared to the high tone. In addition, a perceptual study about the different derived tones would shed light on how salient the variation in grammatical tones is to speakers. This study provides the first phonetic account of Mwaghavul’s tonal inventory and establishes an ideal foundation for further research on tone, variation, and tonogenesis in Mwaghavul.

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