JLLE
Vol 19(1) 11–24

DOI:10.56279/jlle.v19i1.2

Luo Tonal Structure: A Phonetic and Phonological Analysis

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Abstract

This paper presents a phonetic and phonological analysis of tonal patterns in Luo, a Western Nilotic language spoken primarily in Kenya and Tanzania. The paper mainly focuses on the classification and representation of lexical and grammatical tones. Drawing on field data, the paper establishes that Luo has four lexical tones—two level tones (High and Low) and two contour tones (Falling and Rising). It also identifies two melodic tonal patterns, HHH and LHLL, for grammatical tones. While level tones show subtle pitch distinctions, consistent with two-tone systems, contour tones appear in both simple and complex forms. The paper adopts Autosegmental Metrical (AM)Theory to account for tonal behaviours, in support of the view that contours in African languages are sequences of level tones that combine to form contour tones. From this perspective, the study concludes that since Luo contrasts two-level tones, it has only two underlying contour tones: HL and LH. Other tonal configurations are surface-level effects. Acoustic evidence also reveals that L tones may exhibit a slight fall, which is attributed to a production effect. Generally, the study concludes that Luo tones are phonologically governed, with AM theory offering a coherent model for explaining the tonal association and contour formation.

Keywords: *Luo, lexical tones, grammatical tones, level tones, contour tones*

Introduction

This study examines the phonetic and phonological aspects of lexical and grammatical tones in Luo by employing digital pitch tracking and analysis methods. The study reflects on the previous studies on Luo tones by proposing a more precise identification of tones. Studies on tone and intonation in African languages have received much attention recently. For example, in the book *Intonation in African Tone Languages*, various scholars have not only explored intonation in African languages but have also shown the role lexical tones play in determining the intonation of a language (Downing & Rialland 2016).

Tone, as opposed to intonation, is pitch specified at the word level to distinguish lexical meanings or grammatical functions (Hyman 2009). Meanwhile, intonation is the pitch variation at the phrasal level, hence post-lexical (Gussenhoven 2004). According to Arvaniti and Fletcher (2021), all languages have intonation, which is specified at the phrasal level (i.e. post-lexical). They add that intonation is a complex interplay between metrical structure, prosodic phrasing, syntax, and even pragmatics.

For tonal languages, tone is contrasted on every syllable or mora, within a word, with the main purpose of distinguishing lexical items or grammatical functions. Therefore, a clearer analysis of lexical and grammatical tones, which are essential inputs to studying the intonation of a language, is important. This is because intonation in tonal languages is also determined by these basic tones. Distinguishing lexical and grammatical tones from post-lexical tones is essential since it highlights what belongs to the phonology and what is reflected in the syntax and pragmatics of a language. For example, lexical tones change the meanings of words while post-lexical tones, which are found across phrases and sentences, indicate whether an utterance is a statement, question, emphasis or focus. Therefore, misinterpreting the two can lead to a misunderstanding.

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Previous studies on Luo tone and intonation (e.g. Tucker & Creider 1975; Creider 1978; Omondi 1982; and Tucker 1994) have not only inconsistent number of tones available in Luo but have also had issues in differentiating lexical and post-lexical tones. First, these scholars argue for a varied number of tones from two to several. For example, Creider (1978) identifies three basic tones, namely High, Low and Falling. He also reports a downstepped tone as a derived tone, which occurs after a high or a falling tone. Omondi (1982), on the other hand, argues for two basic tones, which are High and Low and two derived tones, which are Rising and Falling. In her analysis, Omondi stipulates that rising and falling tones are found in derived contexts and do not occur as basic tones. Meanwhile, Tucker (1994), with the highest number of tones, reports the presence of High level, Extra high, Downstepped high (Mid), Low, Low descending, High falling, Long high falling, Extra high falling, Rising, Falling-rising, Rising-falling and Compound tones. Generally, these studies do not succinctly identify which tones are lexical, grammatical or post-lexical.

The variations on the number of tones in Luo, from the previous studies, might be due to different methodological approaches used by the researchers or even the criteria used to distinguish tones. For example, Omondi's approach and analysis of Luo tones are based on auditory perception. Auditory analysis is inherently subjective, as different listeners may perceive pitch contrasts differently. Moreover, human hearing and perception may have limited precision in distinguishing subtle pitch variations, especially in complex tonal environments where multiple linguistic cues might overlap. This subjectivity can lead to inaccuracies in identifying pitch levels or contours. On the other hand, Tucker and Creider (1975) used a tonometer and pitchmeter, which are in essence musical instruments, to determine the different tones available in the language. Tucker (1994) admits that the solfa renderings from the tonometer readings reflect tonemes rather than tones and are not tied to absolute pitch levels.

Therefore, this paper presents the phonetic and phonological characteristics of tones in Luo. The study uses *Praat* to determine the presence of basic tones in the language. By using modern digital tools for acoustic analysis, as opposed to traditional auditory and musical analyses, the different types of tones in Luo are determined. This modern approach is more convenient as it offers more objective and precise measurements of pitch that are important in determining the types of tones in Luo. Furthermore, some instances of lexical tones interacting with post-lexical tones and affecting the tonal structure as a whole are also highlighted.

Luo and its Tonal Typology

Luo is a Western Nilotic language within the Nilo-Saharan language family. The language is predominantly spoken in western Kenya and northern Tanzania by approximately 4 million speakers (Eberhard et al. 2024). In this study, only Luo speakers from Tanzania were involved.

As outlined above, tones play a crucial role in the grammar of a language. A clearer understanding of tonal typology is also essential for the correct interpretation of the tonal processes observed in a language. This is because each language has a unique set of rules for how tones operate.

In Autosegmental Theory by Goldsmith (1976), it is proposed that every tone must be associated with some tone-bearing unit (henceforth TBU), and every TBU must have a tone, at least on the surface. The TBU can be a syllable or a mora. Yip (2002) also notes some cases where tones can be directly associated with the segments, rather than morae or syllables. In the case of Luo, a syllable is the TBU (See Ombijah 2020 for further clarification). According to Yip (2002), one of the diagnostics for a syllable being the TBU is that the language should allow contour tones on both light and heavy syllables. This means two auto-segmental tones are associated with a syllable and not a mora, a case which is also observed in Luo.

Tonal typology is one of the longstanding interests of theorists and fieldwork researchers (Hyman 2010). The main concern has been to typologize a language by determining which

tones are phonologically specified or underspecified. The proposed systems are equipollent and privative (Hyman 2001, 2010). Hyman (2001) proposes some potential criteria to establish whether both High and Low tones are phonologically activated in a language, to yield an equipollent system, or only High tone is specified to yield a privative system. In the privative system, a syllable or mora, whichever is considered a TBU, would receive a default Low tone or remain toneless. The privative system is mostly found in Bantu languages. The tone in Bantu has a binary distinction where one tone is marked and the other is unmarked.

Regarding an equipollent system, both tones are said to be marked. One of the criteria to identify an equipollent system is the presence of either a Rising (LH) or a Falling (HL) contour on a single TBU. In such a case, the possibility is that both H and L are active in the language. Luo has examples of Rising (LH) and Falling (HL) contours on a single syllable, as portrayed in (1).

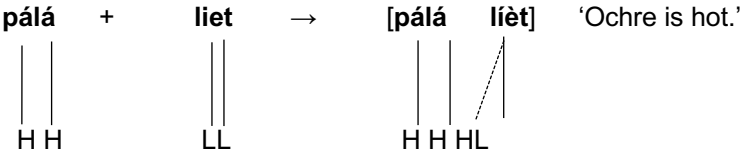
(1)

Luo word	**Tonal pattern**	**Gloss**
cwă	LH	‘tamarind’
lăw	LH	‘cloth’
kîŋ	HL	‘tomorrow’
sabûn	HL	‘soap’.

Source: Field data 2017-2019

Apart from having rising and falling contours occurring as basic lexical tones on a single TBU, these contours can also appear in derived contexts. The derivation can be observed through tone spreading, as shown in (2) below. In this example, the H tone of the noun **pálá** ‘ochre’ spreads to the low-toned word **liet** ‘hot’, resulting in a falling contour (HL). Omondi (1982) and Tucker (1994) refer to this kind of process as tonal assimilation, where an H tone spreads rightwards targeting an L tone. In the studies of tones, this is referred to as high tone spreading (HTS). The H tone spreading in (2) is non-iterative and creates a falling contour when it spreads to an L-toned syllable. It can also surface as an H tone when it spreads to a toneless syllable (Ombijah 2020). Such a non-iterative environment is referred to as High Doubling in Bantu (Bickmore & Kula 2013).

(2)



‘Ochre is hot.’

Source: Adapted from Tucker (1994:338)

Another criterion that determines an equipollent system is when an H tone or L tone occurs as a floating tone (Hyman 2001). Theoretically, it is assumed that a floating tone results from a deleted segment or can be traced historically and causes some segmental changes (Yip 2002; Gussenhoven 2004). The floating tone can motivate or block certain phonological processes. In Luo, this case is found in contracted imperatives, when the vowel of the full imperative *-í* is deleted in contracted forms and its high tone is carried by the rest of the syllable. A list of full imperatives and the corresponding contractions is given in (3), and the derivation process is illustrated in (4). According to Hyman (2001), this process suggests that the H tone is phonologically active, but it does not override the underlying L tone, hence creating a rising contour (LH).

(3)

VERB	FULL IMPERATIVE	SHORT IMPERATIVE	GLOSS
nindo	**nindí**	**nĭnd**	‘sleep’
riŋgo	**riŋgí**	**rĭŋg**	‘run’
tedo	**tedí**	**tĕd**	‘cook’

(4) **nindí** → **nĭnd** 'sleep'

Source: Ombijah (2020)

Another piece of evidence for floating tone is given by Tucker (1994) when presenting the implicit downstep case. As shown in (5), a floating L causes downstep of the subsequent Hs. Tucker argues that the verb **kélô** 'to bring' has an underlying falling contour (HL) on the second syllable, and the L tone of the contour downsteps the subsequent Hs in the following word **gúén** 'chicken'. Here, we see the floating L tone, which is delinked on the surface, motivating the downstep of Hs. The downstepped H tone (marked by an exclamation mark) is an example of a post-lexical tone.

(5) Word tier: **or** **kélô** **gúén** → [**or** **kéló** **ꜜgúén**]

Tonal tier: L H HL HH L HH(L) ꜜHH
Gloss: 'In-law brings chicken'

Source: Adapted from Tucker (1994:343)

Based on the examples provided above, it is evident that both L and H tones are phonologically activated in Luo, suggestive of an equipollent system (H vs L). However, Hyman (2001) proposes that a language may start as a privative (H vs ∅) system where one of the tones is unspecified but becomes equipollent where both tones are active during derivation. In that case, it is also possible to have a tonal system with H vs L vs ∅. Due to the nature of tones provided through (1) to (5), we can agree that Luo has H vs L vs ∅, both in underlying forms and in derived contexts.

Theoretical Framework

This study uses the Autosegmental Metrical (AM) Theory to analyse tonal operations. The AM Theory is useful in describing the intonation and prosodic structures of languages. The term "Autosegmental-metrical" reflects its foundation in two distinct theories. As Gussenhoven (2002) explains, the model is considered "autosegmental" because it represents segments and tones on separate but parallel tiers. This follows the principles introduced by Goldsmith (1976). It is also metrical because it incorporates a hierarchical structure of phonological units, ranging from individual segments to syllables, feet, phonological words, phrases and intonation phrases (Gussenhoven 2002, 2004; Arvaniti & Fletcher 2021). Ladd (2008) adds further that the AM theory caters to both phonological and phonetic goals by characterising contours in a string of phonological elements and then mapping them into continuous acoustic parameters. Hence, the AM Theory is suitable because it provides a framework to interpret the prosodic elements of speech directly represented in pitch contours. Hence, the theory operates not only within words but also beyond the word level.

The AM Theory is relevant in this study for three reasons. First, it represents High (H) and Low (L) tones as abstract phonological units associated with metrically strong positions such as stressed syllables (for intonational languages) and prosodic boundaries (Arvaniti & Fletcher 2021). Second, the theory separates phonological structure and phonetic implementation. This separation is important as it allows generalisations about certain pitch patterns without necessarily encoding every pitch movement (ibid). Lastly, the theory effectively handles the issue of the number and types of tones. The theory supports the analysis of pitch in terms of levels (High and Low) rather than movements or configurations,

reducing the complexity in pitch contour representation. Given its flexibility, the theory is useful in analysing the different tonal behaviours observed in Luo.

Materials and Methods

This study was conducted in Rorya and Tarime districts in Tanzania. These are areas where Luo is predominantly spoken in the country. Data were collected during fieldwork between 2017 and 2019. Four native speakers (two females and two males) participated in this study. Participants were given a script of Luo words to read aloud. This was done in a controlled environment to ensure uniformity and consistency across different recordings. Every word was repeated thrice to minimise the initial and final effects. The determined pitch range floor for the analysis was 75 Hz. This was meant to capture even the lowest pitch ranges. The list had words with 16 possible tonal patterns in the language. Since each word was produced 3 times by each speaker, a total of 204 tokens were produced. The list of words is provided below in Table 1.

Table 1: List of Words with 16 Possible Tonal Patterns in Luo

S/N	WORD	TONAL COMPOSITION	GLOSS
	MONOSYLLABIC WORDS		
1	**Pi**	L	'water'
2	**Món**	H	'women'
3	**cwă/lăw**	LH	'tamarind/cloth'
4	**kîŋ**	HL	'tomorrow'
	DISYLLABIC WORDS		
5	**mba.ka**	L.L	'story'
6	**no.nó**	L.H	'empty'
7	**sa.bûn**	L.HL	'soap'
8	**ná.ngá**	H.H	'garment'
9	**ŋí.en**	H.L	'new'
10	**má.côn**	H.HL	'old'
	MULTISYLLABIC WORDS		
11	**ŋa.kwa.ro**	L.L.L	'grandchild'
12	**o.du.má**	L.L.H	'maize'
13	**a.cí.el**	L.H.L	'one'
14	**o.bám.blá**	L.H.H	'dried fish'
15	**ó.má.ŋó**	H.H.H	'finding/looking for'
16	**o.mâ.ŋo**	L.HL.L	'has found/has looked for'

Source: Field data, 2019

As outlined in Table 1, each set had the targeted tones, that is, L, H, HL, and LH. The tonal patterns are either lexical or grammatical tones specified on the syllable, which is the TBU. It is observed in the prescribed Luo tonal patterns that High and Low tones can occur anywhere in a syllable, while Rising (LH) and Falling (HL) are restricted to the final syllable or at the penult. The first set comprised words with one syllable (monosyllabic). The second set comprised words with two syllables (disyllabic), and the third set comprised words with three or more syllables (multisyllabic).

The recordings were done with an M-Audio MicroTrack II Professional Recorder with a Cliptec BMH699 microphone mounted on it, to minimise surrounding noise. Audio WAV files were transferred from the digital recorder to the computer for digital analysis. The pitch trends were computed by *Praat* software version 6.0 - 6.1 (Boersma & Weenink 2017–2020). The acoustic analysis involved examining the fundamental frequency (F0), which is modelled in Hertz (Hz). The F0 is the physical correlate of pitch from speech waveforms

(Pierrehumbert 1980). The higher the frequency of the vibration of the vocal cords, the higher the fundamental frequency. The WAV files produced had a minimum recording rate of 44.1 kHz. Pitch tracks were plotted against a time scale to provide a visual representation of the F0. The visual representations of pitch were then used to argue for the presence of a High, Low, Rising or Falling tone, as stipulated in the Autosegmental-Metrical Theory.

Results

Lexical Tones

Low Tone

The first type of tone identified is a low tone (L tone). This tone can be found in monosyllabic, disyllabic or multisyllabic words. Here I have chosen the monosyllabic word **pi** 'water' and the disyllabic word **mbaka** 'conversation/story' to use as examples. The acoustic signals for these words are shown in Figures 1 and 2, respectively.

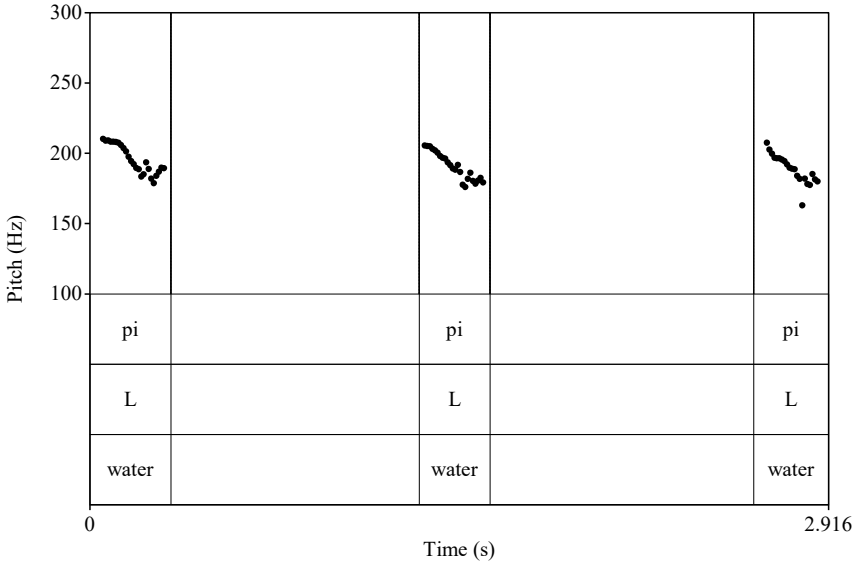


Figure 1: Three Repetitions of the Monosyllabic L-toned Word Pi 'Water'

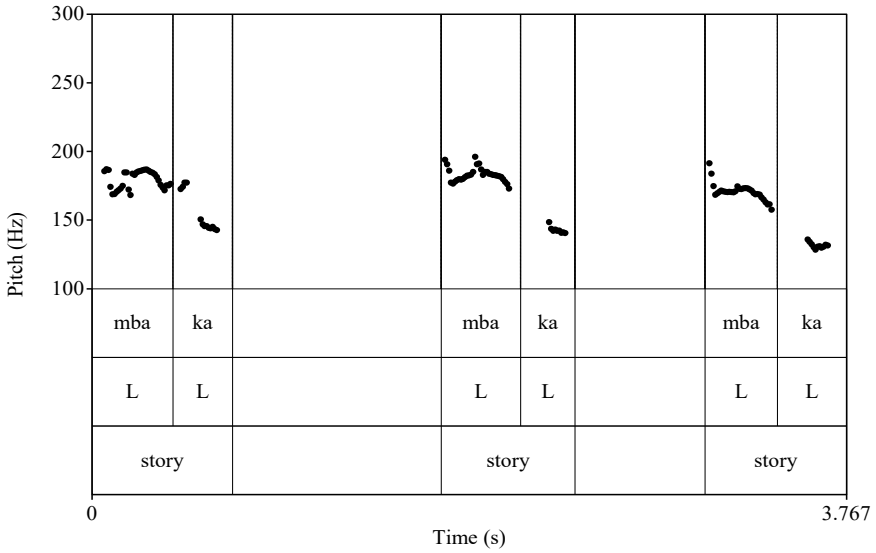


Figure 2: Three Repetitions of the Disyllabic Word Mbaka 'Story' with an LL Tonal Pattern

The pitch tracks in Figures 1 and 2 above indicate a falling effect. This is a drop of pitch to the bottom of the speaker's pitch range. This falling effect makes L tones in these figures appear as falling contours rather than level lows.

High Tone

Apart from the low tone, Luo has an H tone. A monosyllabic word **món** 'women' and a disyllabic word **náŋgá** 'cloth' have been used as examples and are illustrated in Figures 3 and 4, respectively. H-toned words in these figures are phonetically manifested with a sustained level syllable-finally, where the subsequent H tone in the word **náŋgá** 'cloth' downstepped. From these Figures, it is observed that when words have H tones, the pitch of the final syllable does not fall to the bottom of the speakers' range to create a falling effect, as seen in the low-toned words above.

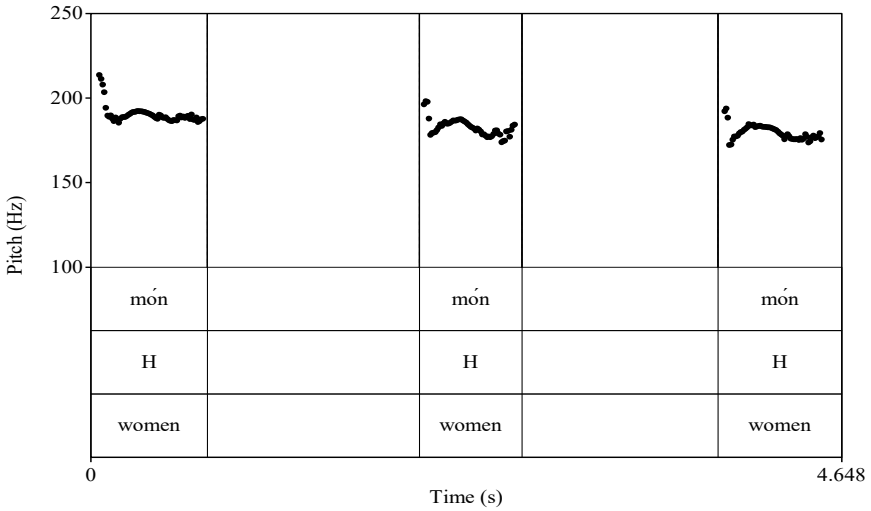


Figure 3: Three Repetitions of the H-toned Monosyllabic Word Món 'Women'

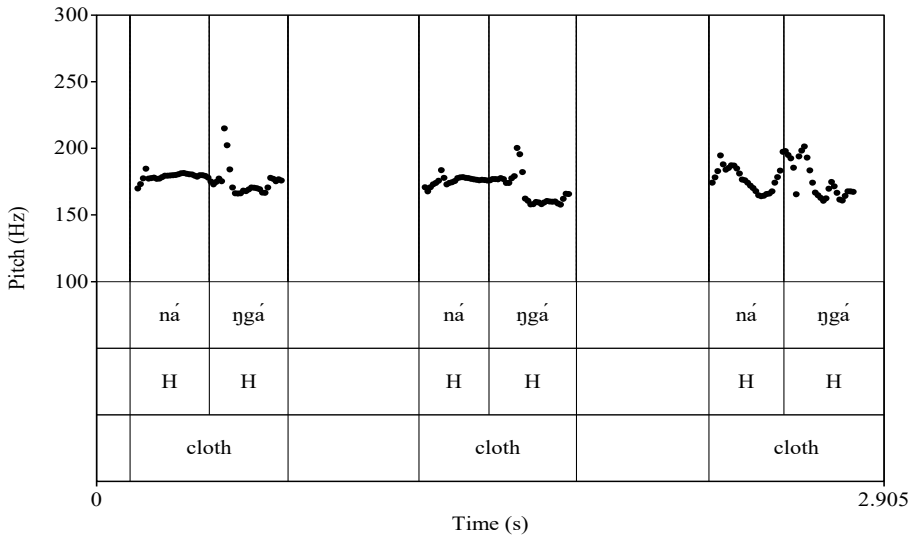


Figure 4: Three Repetitions of the Disyllabic Word Náŋgá 'Cloth' with an HH Tonal Pattern

The pitch tracks observed in Figures 1 to 4 show that both H-toned and L-toned words are produced between 150Hz and 200Hz. Although the estimated difference observed is subtle, there is still a notable difference between L tone and H tone. To measure this difference, F0 values of the L-toned word **mbaka** and the H-toned word **náŋgá** were aggregated and computed from the four speakers. The computation of 12 tokens, that is, three repetitions per participant, shows that H tones are relatively higher than L tones. This is clearly illustrated in Figure 5 below.

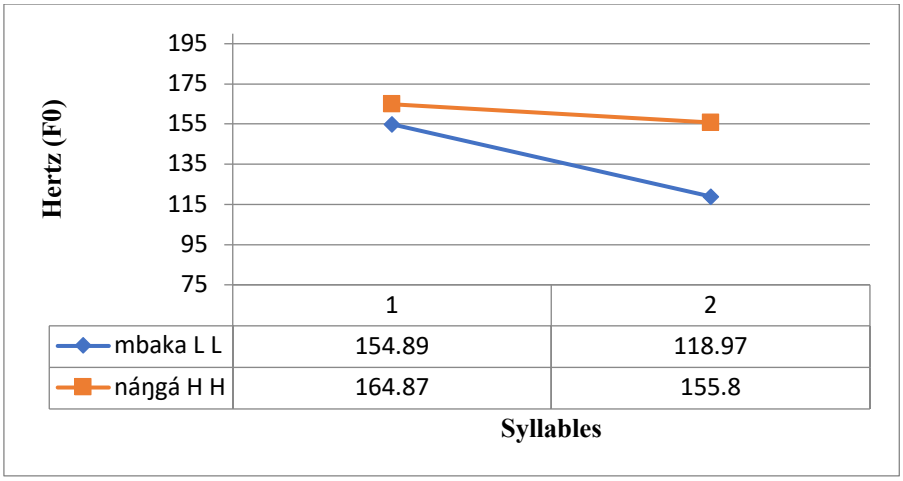


Figure 5: Average F0 Values of H-toned Words (in orange) vs L-toned Words (in blue), Aggregated from the Four Speakers

The average pitch value of the initial syllables of the L-toned word **mbaka** is 154.89 Hz, and that of the H-toned word **náŋgá** is 164.87, with a difference of 9.98 Hz. The second syllable of the L-toned word **mbaka** is 118.97 while that of the second syllable of the H-toned word **náŋgá** is 155.8 Hz, with a difference of 36.83 Hz. On average, the L tone is produced at a lower pitch while portraying a falling effect on the second syllable. Meanwhile, the H-toned is relatively higher with a sustained H on the second syllable.

Falling Tone (HL)

F0 analyses show that Luo has two types of contours, which are Falling (HL) and Rising (LH). For falling contours, consider the illustrations for the words **kîŋ** (HL) 'tomorrow' and **sabûn** (LHL) 'soap', shown in Figures 6 and 7, respectively. Figure 6 shows a simple fall on the monosyllabic word **kîŋ**, while Figure 7 shows a complex fall (rise-fall) on the second syllable of the word **sabûn**

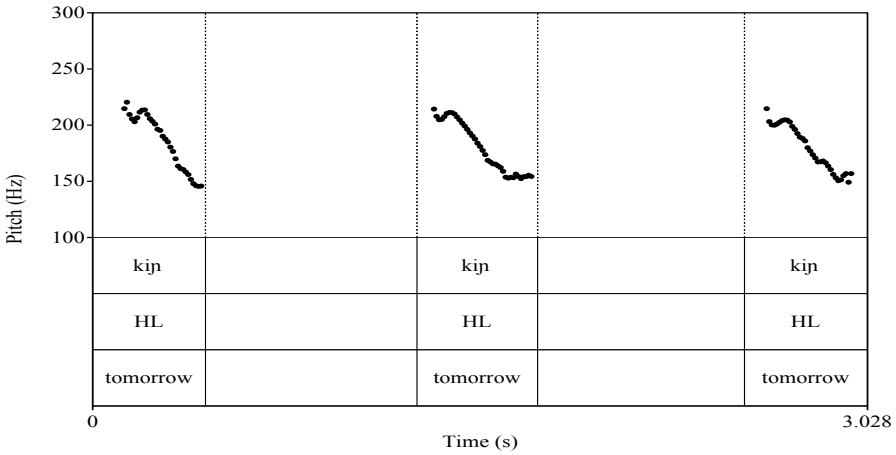


Figure 6: Three Repetitions of the Monosyllabic Word Kîŋ 'Tomorrow' Showing a Simple Falling (HL) Contour

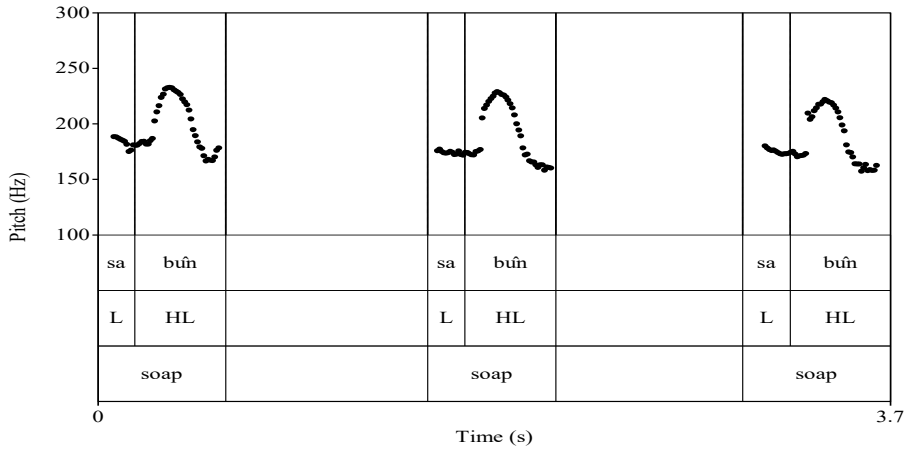


Figure 7: Three Repetitions of the Disyllabic Word Sabûn 'Soap' Showing a Complex (rise-fall) Contour

Both low tone and falling tone exhibit a falling effect syllable-finally. However, it is noted that the difference between the maximum and the minimum pitch value is 35.30Hz for **pi** 'water' and 67.52Hz for **kîŋ** 'tomorrow'. This indicates that **kîŋ** (HL) has a phonetically significant fall than **pi** (L).

Rising Tone

In the case of a rising contour (LH), two monosyllabic words **lăw** 'cloth' and **cwă** 'tamarind' are used as examples for a simple and a complex rise, respectively. In Figure 8, the word **lăw** shows a rise from a level low tone that is below 200Hz, going upwards, creating a simple rise. Meanwhile, in Figure 9, the word **cwă** begins with a fall from the high pitch (i.e. 220Hz) targeting a low tone below 200Hz, followed by a shallow rise, creating a complex contour.

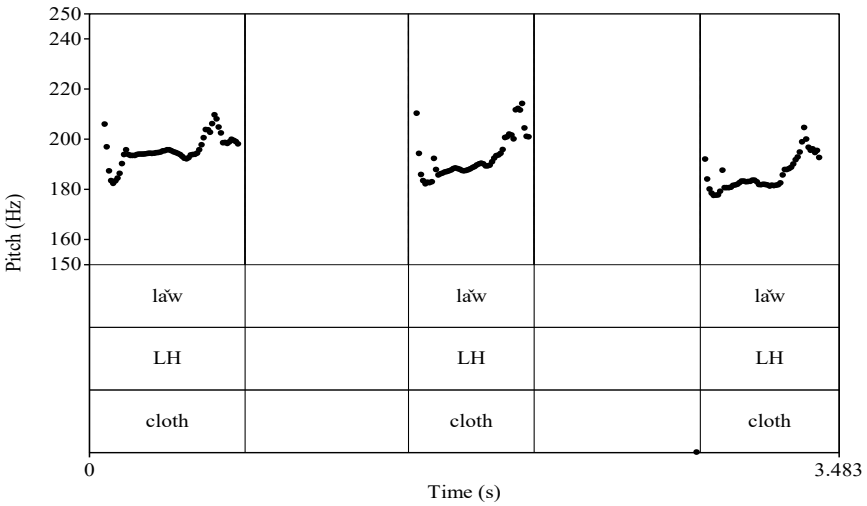


Figure 8: Three Repetitions of the Monosyllabic Word Lăw 'Cloth' Showing a Simple Rise Contour

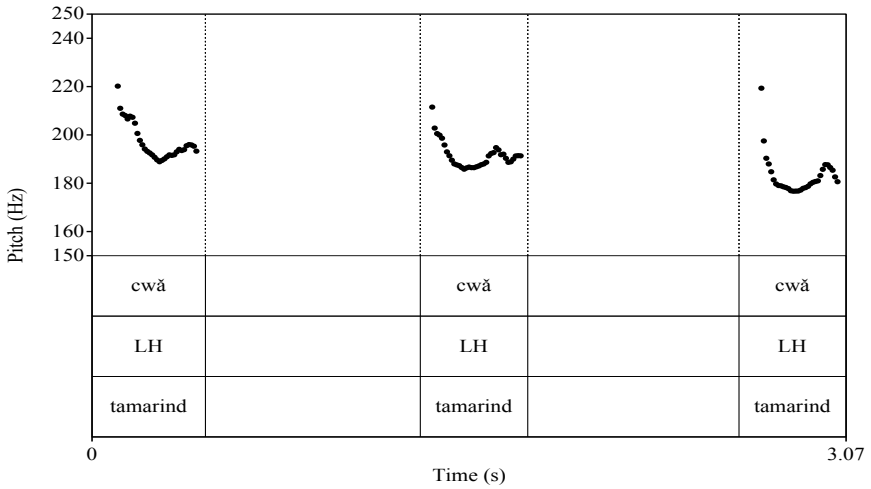


Figure 9: Three Repetitions of the Word Cwă 'Tamarind' Showing a Complex Rise (fall-rise) Contour

Generally, contour tones can be simple as in Figures 6 and 8 or complex as in Figures 7 and 9. Simple contours involve a one-way fall or rise, while complex contours start with a rise followed by a fall or a fall and then a rise, creating convex and concave shapes, respectively. However, it should be noted that the simplicity or complexity of a contour shape might be affected by other segmental factors such as voicing or sonority. Thus, the distinction between simple and complex contours in these cases is simply based on the observed F0.

Grammatical Tones

Besides lexical function, tone in Luo has a grammatical function. This function includes, among other things, aspectual distinction. The aspectual distinction is portrayed when particular tones are associated with a specific tense/aspect/mood (i.e. TAM). Such tones are known as melodic tones. The melodic tones which signal verb tense-aspect are obtained by modifying the tone(s) of the root or stems. In Luo, the underlying tonal pattern for verbs is L, as in **maŋo** 'to find'. To mark the progressive aspect, there is an insertion of melodic H tone(s) producing the HHH tonal pattern. As illustrated in Figure 10, the H tone on the first syllable begins high, above 200 Hz, but the subsequent Hs are downstepped, that is, they are produced relatively lower than the previous H (below 200 Hz).

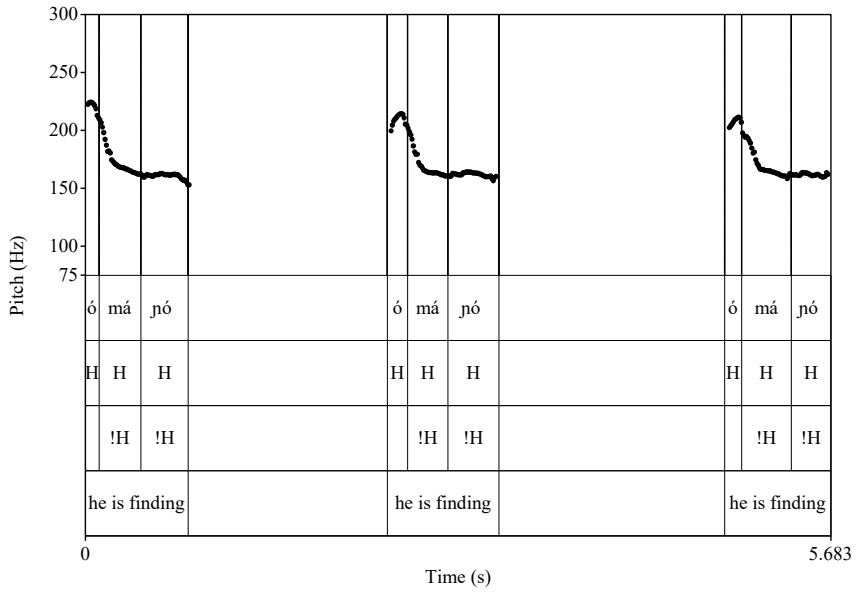


Figure 10: Three Repetitions of the Word Ómáŋó 'he is Finding/Looking for (sth)' with an HHH Tonal Pattern

For the progressive aspect, Odden (1996) argues that verbs can be assigned a floating H, which is mapped to the first or second stem vowel as determined by the tense or aspect of the verb. In this case, the first vowel of the progressive aspect receives an H tone, which then spreads unboundedly to the rest of the verb, when it is non-final, as shown in (6). Melodic Hs remain the same even when the tense changes from present to past progressive, as noted in (7). Note that the H tones in the word **náŋgá** 'cloth' are lexical tones, not melodic tones.

(6) **ó-máŋó** **náŋgá**
SM3SG-PROG.find cloth
'S/he is looking for a cloth.'

(7) **né-ó-máŋó** **náŋgá**
PST- SM3SG-PROG.find cloth
'S/he was looking for a cloth.'

Source: Field data, 2017-2019

However, if the verb is sentence final as in (8), the high tone spreading to the final syllable is blocked, indicating a low boundary at the end of a sentence. The low boundary is the effect of final lowering, which is an extra dose of lowering at the end of an utterance regardless of the preceding context (Gussenhoven 2004).

(8) **ó-máŋò**
H L%
SM3SG-PROG.find
'S/he is looking for (something).'

Source: Field data, 2017-2019

On the other hand, the perfective aspect is marked by an LHLL melodic tone as illustrated in Figure 11.

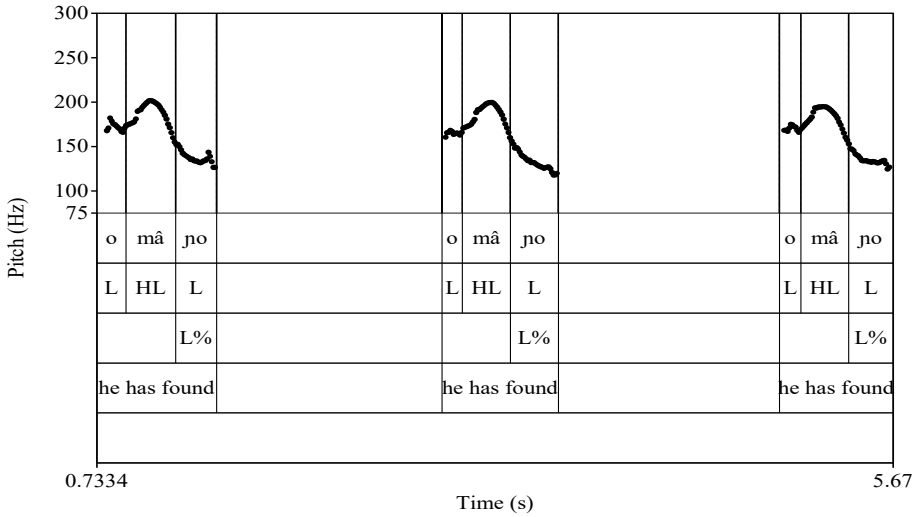


Figure 11: Three Repetitions of the Word Omâŋo 'he has Found/Looked for (sth)' with a LHLL Tonal Pattern

Regarding the perfective or completive aspect, the assumption is that an H tone is inserted on the first syllable of the stem or root, which in turn surfaces with a falling contour (HL). See example (9) below. In addition to this pattern, the perfective aspect is also marked by the prefix o- (which is homophonous with the 3rd person singular o-).

(9) **o-mâŋo** **náŋgá**
SM3SG-PRF.find cloth
'S/he has looked for a cloth.'

Source: Field data 2017-2019

Discussion

This paper analyses the acoustic features and the phonological representation of Luo tones. By doing so, the paper shows which tones are lexical and which ones are grammatical or post-lexical.

The data, as presented from Figures 1 to 9, indicate that Luo has four lexical tones, which are divided into level and contour tones. The level tones are Low (L) and High (H) tones. However, it is observed that the distance between the two level tones is subtle, as portrayed in Figure 5. According to Maddieson (1978), languages that contrast two-level tones, like Luo, have a smaller distance between the two tones compared to languages that contrast three or four level tones.

Apart from level tones, data also reveal that Luo has two main underlying contours, Falling (HL) and Rising (LH). These contours can either be simple (as in Figures 6 and 8) or complex (as in Figures 7 and 9). Proposing two underlying contour tones relies on the assumption that contours are made up of level tones. This is also supported by Yip (2002), who argues that if a language has two level tones, then the expected contours are HL and LH. According to Yip (2002), as well as Ladd (2008), contour tones in African languages are treated as sequences of level tones rather than units. This is contrary to most Asian languages, such as Mandarin and Cantonese, which treat contour tones as unitary elements that cannot be decomposed into level tones. The AM Theory, being a two-tone theory (Pierrehumbert 1980), helps in resolving this long-standing controversy between tone levels and tone configurations in African tonal languages.

In the previous studies of Luo tonal structure, contour tones have been portrayed differently. For example, Omondi (1982) argues that rising and falling contours are derived tones from tonal contraction or tonal assimilation. Despite her argument, she still provides examples where the falling contour occurs as an underlying lexical tone in a non-derived context. Contrary to Omondi (1982), Tucker (1994) gives extensive examples where both falling and rising contours occur as lexical or derived tones. In this paper, I argue that the two underlying contour tones, that is, HL and LH, are the ones which are phonologically specified, and all other contours, such as high falling, extra high falling, long high falling, falling-rising and rising-falling are surface tones which occur due to other orthogonal factors. For example, the so-called extra high tone only appears in phrasal context, aiming at producing different pragmatic meanings (Tucker 1994).

It is also observed that a low tone and a simple falling tone, in Figure 1 and Figure 6, respectively, have similar contours but are not acoustically identical. According to Yip (2002), both low and falling tones can have a falling effect, but if the fall is small and phonologically irrelevant, that particular tone should be treated as a level tone rather than a contour tone. This is because when producing a very low-toned word, it takes time for the voice to drop to the lowest pitch, due to production effects. Tucker (1994) in his analysis refers to the fall in low tones as a downdrift effect. As noted earlier, the difference between the maximum and the minimum pitch value is 35.30Hz for an L-toned word **pi** 'water' and 67.52Hz for a falling tone **kîŋ** 'tomorrow', indicating that the falling tone is significantly steeper than the L tone.

This phenomenon has been observed in all L-toned words in isolation, regardless of the number or the structure of the syllables. This means both monosyllabic and multisyllabic words, as well as open and closed syllables, can have a falling effect, which is considered a production effect (see Gussenhoven 2004 for more clarification about the production effect). Tucker (1994) adds that the falling cadence sometimes depends on the speaker, occasion and context. For example, male speakers may portray a steeper fall than female speakers.

Furthermore, data indicates that Luo contrasts grammatical tones. Figures 10 and 11 portray acoustic cues for the progressive aspect and perfective aspect of the verb **maŋo** 'find', which is inherently L-toned. Borrowing from Odden's (1996) analysis, the verb root in Luo receives an H tone which spreads unboundedly to all syllables, as in examples (6) and (7) above. The spreading may be blocked syllable finally, as in example (8). Blocking the H tone at the final position shows an instance of edge tone effect as propounded in the AM theory. For the perfective aspect, the verb stem **maŋo** receives an H tone on the first syllable, which then creates a falling HL contour **mâŋo**, unlike the progressive aspect, where the tone spreads to the other syllables. Furthermore, a prefix o- is added to complete the perfective function of the verb, creating a word like **omâŋo** with an LHLL melodic pattern.

As noted in Figure 10, the progressive aspect is marked by an HHH melodic pattern. However, the last two tones are downstepped, creating an H!HH surface. Downstep is a phonological process in most tonal languages. In Luo, it can be an automatic downstep, where an overt low triggers the lowering of H tones, or a non-automatic downstep, where a covert/floating low triggers the lowering of H tones, as observed in H!HH melodic tones. In AM theory, this kind of downstep is considered an example of localised tonal changes, where the change in tone is triggered by the phonological environment where the tone occurs. In Luo, downstep is common not only in words but also in phrases, simple sentences and even in complex sentences (Ombijah 2020; 2025)

Conclusion

This study has refined our understanding of Luo tones by identifying and analysing the four basic tones, High and Low as level tones, and Rising and Falling as contour tones. There is a subtle but significant difference between L and H level tones. An L tone can be manifested with a falling effect, which is more of a phonetic effect rather than a phonological representation. Moreover, the study has also portrayed the role of tone in differentiating aspects, hence grammatical tones. Two tonal melodies, that is, HHH and LHLL, have been identified as markers of progressive and perfective aspects, respectively. These findings show an interplay between phonetics and phonology in tone realisation, suggesting that while some tonal effects may appear phonetic, they also have phonological implications that can influence the structure of Luo tones.

The application of Autosegmental Metrical theory has also been vital in demonstrating that level tones, though distinct, can interact to form complex contour patterns. This approach has revealed the complexity of the Luo tonal system, indicating that its tonal structure is more intricate and systematically organised within the Autosegmental-Metrical framework. This analysis goes beyond auditory and musical perceptions and provides a robust framework for interpreting the tonal system through more precise digital pitch measurements. To some extent, this study has resolved previous disparities and has also set a precedent for future research in tonal languages, highlighting the importance of digital analytical tools in uncovering tonal phonology.

Declaration of conflicting interests

The author declares that there are no conflicts of interest regarding the authorship and publication of this paper.

Funding

This study was funded by the Commonwealth Scholarship Commission.

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