

Acoustic Analysis of Lahu Nyi Tone System

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ABSTRACT

This study represents the first acoustic analysis of the seven-tone system of Lahu Nyi, a dialect of Lahu, a Tibeto-Burman language spoken in Muang Na subdistrict, Chiang Dao district, Chiang Mai province, Thailand. One male and two female native speakers produced the seven tones in isolation and in a sentence context. Pitch contour analysis showed five long tones in open syllables and two short tones in syllables closed with a glottal stop. Low tones are slightly breathy. Pitch contour modification was observed in the sentence context produced by the male speaker where a high-mid falling tone exhibits a rising contour in the context of a following high-mid falling tone.

Keywords: Lahu Nyi, tone, F0 patterns, glottalization, duration

1. INTRODUCTION

The Lahu language belongs to the Central Loloish branch of the Lolo-Burmese subgroup of Tibeto-Burman languages [9]. 102,876 Lahu people were reported to live in 11 provinces of Thailand in 2015 [4]. Bradley [1] identified five Lahu dialects spoken in the country as (1) Lahu Na; (2) Lahu Nyi; (3) Lahu Shehleh; (4) Lahu Shi Bakeo; and (5) Lahu Shi Banlan. However, Matisoff [9] argued that, based on linguistic criteria, there are only two main dialects of Lahu: Black Lahu (Lahu Na) and Yellow Lahu (Lahu Shi). According to Matisoff [9], Lahu Nyi or Red Lahu is a subvariety of Black Lahu. Consistent with Matisoff's claim, Bradley [1], Lewis [5] and Sirisai [12] pointed out that the Lahu Nyi and Lahu Na dialects are mutually intelligible.

Most studies of Lahu focused on its phonology and grammar, and Black Lahu has received the most attention. James Matisoff documented its phonology [9], examined the relationship between the high-rising tone and glottalization [6], and wrote the grammar of Lahu [7], the Dictionary of Lahu [8], and the English-Lahu Lexicon [10]. Lewis [5] wrote Lahu-English-Thai dictionary. The phonology of Lahu Bakeo has been documented by Suknaphasawat [13], and the phonology of Lahu Nyi was studied by Sirisai [12].

According to Sirisai [12], the Lahu Nyi dialect spoken in Mae Chan district of Chiang Rai, Thailand has 28 consonants, 9 monophthongs and 6 diphthongs with C(C)V(V)T syllabic structure where T stands for lexical tone.

Lahu Nyi contrasts 7 tones: three pairs of checked vs unchecked tones (i.e., T1/T2; T4/T6; T5/T7) and 1 unchecked mid-level tone (T3). The Chao [2] pitch value and their impressionistic descriptions by Sirisai [12] are shown in Table 1.

Table 1: Lahu Nyi Tones according to Sirisai [12].

Tone	Pitch value	Description
1	22	A mid-low level tone
2	22?	A mid-low level tone glottalized tone
3	33	A mid-level tone
4	44?	A mid-high level glottalized tone
5	45?	A high contour glottalized tone
6	44	A mid-high level tone
7	45	A high contour tone

On the other hand, Lewis [5] impressionistically described a Lahu Na dialect spoken in Thailand as having 24 consonants plus a glottal stop. According to Lewis [5], Lahu Na has five tones on open syllables (a high and slightly falling tone, a mid-high rising tone, a mid-level tone, a low-level tone and a low falling tone) and two tones with final glottal stops (a high short tone with a glottal stop and a low short tone with a glottal stop). He also mentioned a number of contexts where a 'tone change' occurs. For instance, he mentioned that the mid-level tone may become a high rising tone when followed by high tones. It is not clear if these tonal alterations are due to coarticulatory effects or a tone sandhi process.

Acoustic studies on any Lahu dialects in Thailand are rare [3]. Cooper [3] conducted an acoustic analysis of Lahu Shi Balan vowels and tones produced by three native speakers from Chiang Rai. According to Cooper [3], Lahu Shi Balan contrasts five tones in open syllables and two short (cut) tones in closed syllables. He also pointed out that falling

tones are often breathy. However, no acoustic measurements are available to collaborate this impressionistic description. To our knowledge, acoustic analysis of Lahu Nyi tones spoken in Thailand has yet to be conducted. The aim of this study is to fill this research gap.

2. THE CURRENT STUDY

The primary aim of this study is to provide, for the first time, an acoustic analysis of the tone system of a Lahu Nyi dialect spoken in Muang Na Sub-district, Chiang Dao district, Chiang Mai, Thailand. Of particular interest is the difference in pitch contours of tones in open syllables (uncut or unchecked tones) and in syllables closed with a glottal stop (checked or cut tones), and between tones in citation forms and in a sentence context. The presence of creaky (glottalization) and breathy phonation will also be explored.

2.1. Speakers

Three native speakers, 1 male (M1) and 2 female speakers (F1, F2) participated in the study. M1 is 42 years old. He holds a master's degree in Political Science. Lahu Nyi is his first language and the language he uses at home. He is also fluent in Thai and has a fair command of English and Chinese, a variety spoken in Yunnan, China. He serves as a spiritual leader in the village and owns a family business. F1 (M1's spouse) is a 30-year old housewife. She completed 6 years of elementary school. Lahu Nyi is her first language. She speaks Thai with a slight accent. She moved from Chiang Rai to Muang Na Sub-district after getting married about 7 years ago. F2 is 54 years old. Lahu Nyi is her first language and the language she uses with her family members. She completed 6 years of elementary school and received a secondary school certificate. She is fluent in Thai and has a good command in Cantonese. She served as the Lahu-Thai interpreter for King Rama IV at the age of 20. She owns a store and a coffee shop.

2.2. Stimuli

Stimuli were /CVT/[-tea] syllables (see Table 2) produced with all seven tones in isolation (by M1 and F2) and in a sentence carrier (by M1 and F1). Since Lahu speakers are not used to producing Lahu words in isolation, each target word was introduced in a context in which it is used. Once the speakers were familiar with the target words, the elicitation procedure proper began.

Table 2: Target words used in the current study.

Tone	Context	Gloss
[tea]1	ta ⁴¹ tea ³³ te ³³	Don't do it.
[tea]2	tea ⁴¹ we ³³	to eat
[tea]3	ʔa ⁴¹ tea ^{44?} k ^h εε ³³	robe
[tea]4	tea ⁴⁵ da ³³ we ³³	to attach
[tea]5	tea ²¹ teεε ²¹	rice plant
[tea]6	tea ^{21?} k ^h ɣɣ ³³	machine
[tea]7	tea ²² la ⁴¹ -a ³³	to feed

For citation tones, target syllables written in Roman script with a tone mark (e.g. ca[^]) were used as prompts for M1. For F2, index cards with meanings written in Thai were used. One repetition of each target word was elicited from M1 and two repetitions from F2 were included in the analyses.

For tone production in a sentence carrier, target words in Lahu written in International Phonetic Alphabets and meanings in Thai were presented on an index card. The researcher gave the context and the meanings in Thai and asked each speaker to produce the target word in Lahu. After being able to produce the target Lahu word, the speakers (M1 and F1) were asked to produce the target word in its context first before producing 5 repetitions of the target syllable [tea] only in the sentence carrier "I ____ say again.":

/ɲa²¹ ____ te⁴¹ pɔ^{44?} k'o^{21?} k'o^{44?} we³³/ (Lahu)
 "I ____ one time only to repeat." (English gloss)

For example, to elicit the target syllable [tea] with tone 2, the speaker would produce the context word /tea⁴¹ we³³/ or "to eat" first, before producing the sentence carrier. That is, the speaker would produce /tea⁴¹ we³³ ɲa²¹ tea⁴¹ (x 5 times) te⁴¹ pɔ^{44?} k'o^{21?} k'o^{44?} we³³/ or "to eat I say eat eat eat eat eat again." To avoid the 'list' effect, the middle three repetitions (repetitions #2, #3 and #4) were used for further analyses.

2.3. Recording

Isolated tone production was recorded on Samsung J7+ cellular phone at 44.1 kHz in a quiet room at M1's house and at F2's store. The recording was then converted from the MP4 to the .wav format for further acoustic analysis.

Tone production in a sentence carrier was recorded at M1 and F1's house, in the same room, using a digital recorder (Marantz, PMD661) and a head-mounted microphone (Shure SM10A) at 44.1 kHz sampling rate and 16-bit amplitude resolution. Each target word was excised from its carrier sentence and

stored as separate files for further analysis. All stimuli produced by M1 and F1 in the sentence context were verified by a native listener (F2).

2.4. Acoustic Measurements

A text grid was created for each target sound file using Praat 6.0.31 [11] to label vowel-onset and vowel-offset. Using both the waveform and the spectrogram displays, vowel onset was defined as the onset of the first full glottal pulse and vowel-offset was defined as the end of the last glottal pulse, excluding creak or vocal fry, if any, to avoid F0 tracking errors. F0 values were then automatically extracted from 20 time-intervals between vowel onset and vowel offset using ProsodyPro [15]. Voice quality measurements were performed using VoiceSauce [14].

3. RESULTS

Results of the acoustic analysis of tones produced in isolation will be presented first followed by those in a sentence context.

3.1. Lahu Nyi tones in citation forms

Figure 1 displays raw pitch contours of the seven tones produced in isolation by M1. Vowel duration for both speakers are presented in Table 3.

Figure 1: Raw pitch contours of citation tones in Lahu Nyi tones produced by a male speaker (M1)

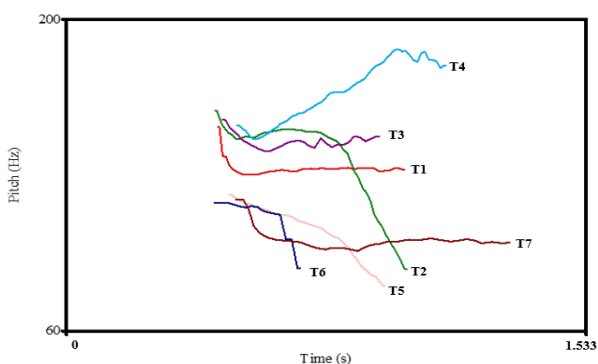


Table 3: Duration of the Lahu Nyi tones produced by a male (M1) and a female speaker (F2).

Tone	Duration (msec)	
	male	female
1	487	489
2	494	415
3	177	131
4	495	480
5	442	452
6	179	153
7	506	575

From Figure 1 and Table 3, we see that Tone 3 and Tone 6 are the shortest and Tone 7 the longest. The remaining tones exhibit intermediate duration value.

Figures 2A and 2B present time-normalized pitch contours produced by M1 and F2 respectively.

Figure 2a: Time-normalized pitch contour of Lahu Nyi tones produced by a male speaker (M1).

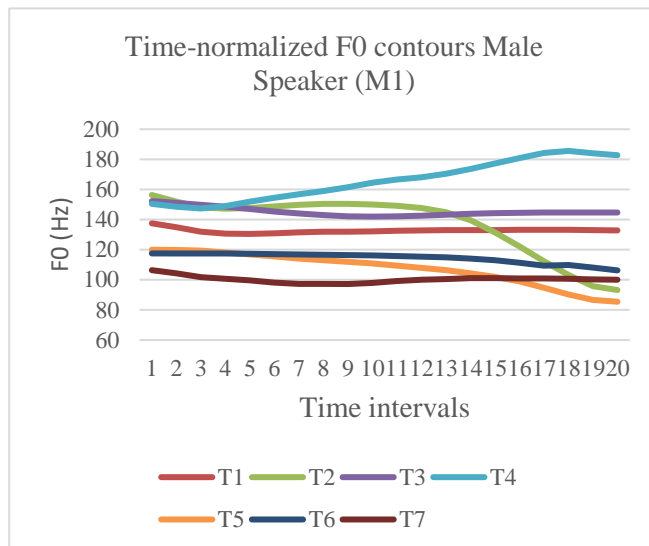
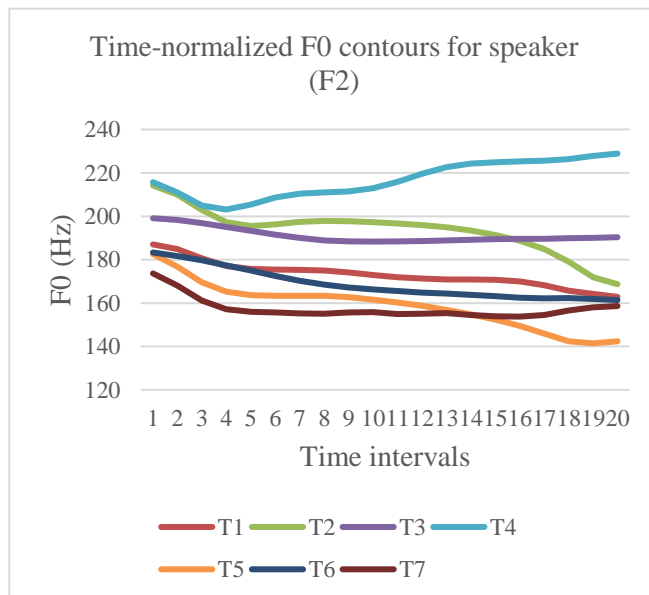


Figure 2b: Time normalized pitch contour of Lahu Nyi tones produced by a female speaker (F2)



Overall, pitch contours for all seven tones are similar between the two speakers. These acoustic results led to our proposed pitch values and description of Lahu Nyi tone system as shown in Table 4.

Table 4: Proposed pitch value and description of Lahu Nyi.

Tone	Pitch value	Description
1	33	A mid-level tone
2	41	A high-mid falling tone
3	44?	A high-mid short tone
4	45	A high-rising tone
5	21	A low-falling tone + slightly breathy
6	21?	A low-falling short tone + glottalization
7	22	A low-level tone + slightly breathy

Interestingly, our Lahu Nyi tone descriptions are largely similar to those of Lahu Na described by Lewis [5] using a larger set of data, but different from those of Lahu Nyi described by Sirisai [12] due, perhaps, to dialectal differences. In addition, we found the two low tones (T5 and T7) to be slightly breathy and exhibited lower Harmonic-to-Noise-Ratio (HNR) between 0-3,500 Hz (1.78 and -2.08, respectively) than all other tones. However, further research with more data is needed to confirm this result.

3.2. Lahu Nyi tones in Sentence Context

Figure 3 and Figure 4 show time-normalized pitch contours of the seven tones produced in a carrier sentence by M1 and F1 respectively.

Figure 3: Lahu Nyi tones in sentence context produced by a male speaker (M1).

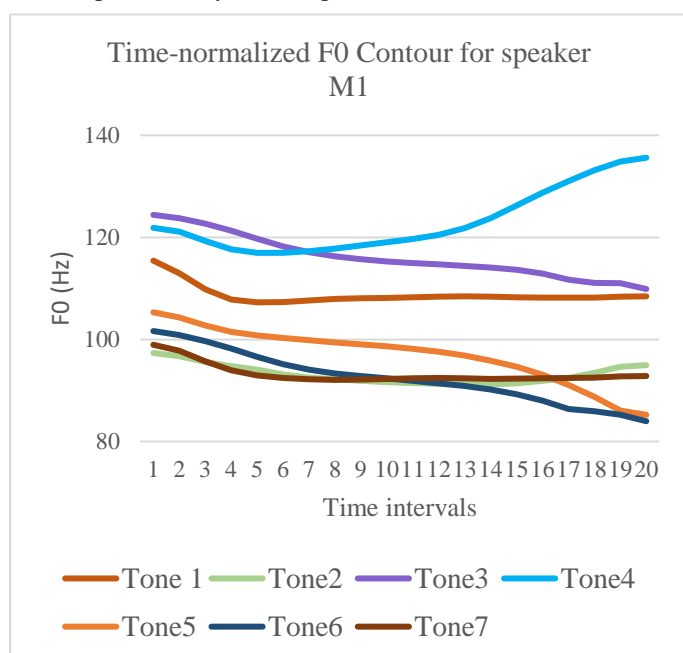
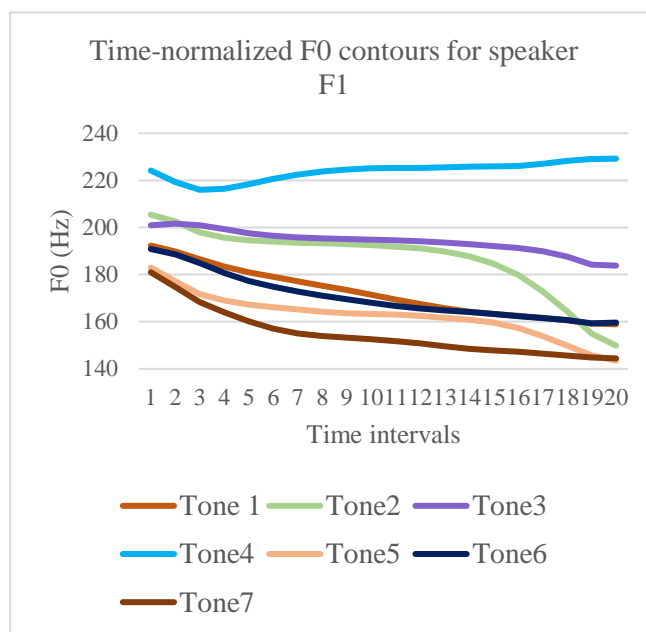


Figure 4: Tones in sentence context produced by a female speaker (F1).



For M1, evidence of tonal alternations (from citation forms) is observed on T2, T3 and T7, with the most noticeable change occurring on T2. Specifically, T2 exhibits a rising instead of a falling contour, while T3 demonstrate a slight fall and T7 a slight rise instead of a level contour. No obvious pitch alternations are observed for F1's production.

4. CONCLUSION

Lahu Nyi spoken in Muang Na subdistrict, Chiang Dao district, Chiang Mai province, Thailand contrasts five lexical tones in open syllables and two lexical tones in syllables closed with a glottal stop. Tones in open syllables (unchecked tones) are longer than tones in closed syllables (checked tones). Glottalization (creaky voice or vocal fry) may accompany a glottal stop in checked tones and low tones are slightly breathy. Pitch contour alterations are observed, particularly for a high-mid falling tone when produced in the context of another high-mid falling tone. More research is needed to confirm the association between low tones and breathiness and pitch contour alternation patterns in different tonal contexts.

5. REFERENCES

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