Tense-lax vowels in Tibeto-Burman languages: a phonetic Analysis of Lahu

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Abstract

This study examines the phonetic nature of tense-lax vowel contrasts in Lahu, a Tibeto-Burman language. By employing acoustic analysis (duration, formants, fundamental frequency, phonation) of minimal pairs produced by four native speakers, we test the hypothesis that the contrast is a syllable-level phenomenon. Results show significant differences in onset consonant duration, vowel quality, tonal duration, and phonation type between tense and lax syllables, while F0 contours overlap. The findings confirm that the tense-lax distinction in Lahu is a coherent, syllable-level property rooted in laryngeal articulation, rather than a feature confined to the vowel.

Keywords: Lahu, tense-lax vowels, Tibeto-Burman languages, acoustic analysis

Introduction

In Tibeto-Burman languages, the tense–lax vowel contrast is a key phonetic feature. Although this topic has received sustained scholarly attention over several decades, the specific phonetic correlates of "tense" and "lax" vowels remain controversial. Early descriptions said tense vowels involved laryngeal constriction, while lax vowels lacked such tension. However, the tense–lax distinction cannot be simply reduced to the degree of laryngeal tension during articulation. In fact, tense and lax vowels in different language show significant differences in phonetic characteristics (Shi, Zhou 2005). Moreover, the so-called term "tense-lax" has not yet had a strictly defined and widely accepted definition in the field of phonetics (Zhu et al. 2011).

Lahu belongs to the Yi Branch of the Tibeto-Burman language family. A salient feature that has sparked sustained academic debate is its "tense-lax vowel" distinction. This contrast's nature has been controversial; some have suggested that it is a non-contrastive phonetic variation, or a mislabeled feature that is better explained by phonation or tonal coarticulation (Matisoff 1982, Zhu et al. 2011, Liu et al. 2024). Lahu has seven tones, among which two tones are associated with tense vowels, and the other five tones are associated with lax vowels (see the Table 1). Matisoff (1982) transcribed the syllables of Tone 5 and Tone 6 as having a glottal stop coda.

Table 1. The seven tones of Lahu.

Lax	Tone value	Words	Tense	Tone value	Words
Tone 1	33	ma^{33} woman			
Tone 2	21	ma^{21} classifier	Tone 5	21	maʔ ^{21} army
Tone 3	54	ma^{54} many	Tone 6	54	maʔ^{54} dream
Tone 4	45	ma^{45}son-in-law			
Tone 7	11/112	ma^{11} teach			

Recent research has shown that phonation is a significant correlate, with modal voice accompanying "lax" vowels and non-modal phonation accompanying "tense" vowels (e.g., creaky voice) (Zhu et al. 2011, Liu et al. 2024). In this study, we use a laryngeal model (for more details, see Thurgood 2007) that combines pitch (F0), vowel quality, and voice quality (phonation) to explain these differences. Our hypothesis is that the Lahu tense-lax distinction is not limited to vowel but rather appears at the syllable level, which includes the onset consonant, vowel, tone, and phonation. By analysing the acoustic correlates throughout the entire syllable, this study seeks to test this hypothesis.

Methodology

The investigation focuses on the Lahu Na dialect, and the recorded materials discussed are based on Zhu et al. (2011). This study carries out a comprehensive acoustic analysis from the aspects of onsets, rime, tones, and phonation. Four speakers (two males and two females) were selected, and the acoustic parameters of 90 pairs of tense-lax contrastive words were analysed and measured using Praat (Boersma & Weenink 2025) and Voicesauce (Shue et al. 2009). The measured parameters include the first and second formants of monophthong rime, duration of onsets and tones, fundamental frequency, harmonic energy difference, harmonic-to-noise ratio, and cepstral peak prominence (CPP).

Results

Acoustic analysis revealed consistent, significant differences between tense and lax syllables across all measured components except for F0 contour. Tense syllables had consistently shorter onset consonants and shorter tonal duration compared to their lax counterparts. For example, the average tone duration for lax syllables was 360ms, while for tense syllables it was only 146ms. Tense-lax status had a significant effect on both F1 and F2. Generally, tense vowels exhibited a lower F1, indicating a higher or more constricted articulation. For low and mid vowels, tense vowels were also more fronted. Furthermore, tense mid vowels showed a consistent tendency toward diphthongization, unlike their lax monophthongal counterparts. After duration normalization (as shown in Figure 1), there was no significant main effect of tense-lax status on F0 contour

(T2 vs T5: p = 0.256 > 0.05; T3 vs T6: p = 0.087 > 0.05). The F0 shapes of tense tones and their corresponding lax tones were nearly identical. This indicates that pitch contour is not the primary acoustic cue distinguishing these syllable types; rather, duration and phonation are the key contrastive features.

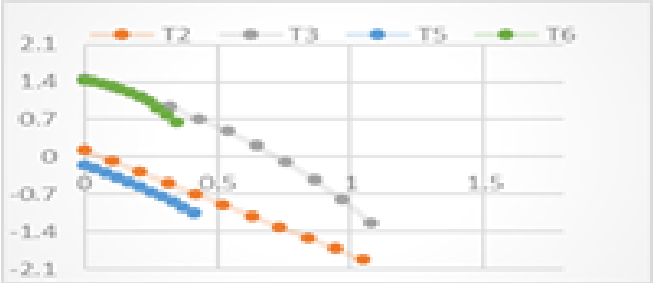

Figure 1. F0 contours of tense-lax vowels in minimal pairs.

All phonation parameters showed highly significant effects. Tense syllables were characterized by creaky voice, while lax syllables used modal voice. For most of the speakers, their lax vowels had positive H1-H2 values, indicating a kind of typical of modal voice. On the other hand, their tense vowels had strongly negative H1-H2 values, which is a classic indicator of creaky or laryngealized phonation. Generally, lax vowels had significantly higher HNR and CPP values, indicating a clearer harmonic structure with less noise. Tense vowels had lower HNR and CPP values, consistent with the aperiodicity of creaky voice.

Discussion and conclusion

The results support our hypothesis that the tense-lax contrast in Lahu is a syllable-level feature. The tense-lax distinction is not confined to the vowel but is realized through a set of coherent phonetic cues in the entire syllable, as summarized in the Table 2.

Table 2. Summary of acoustic differences between lax and tense syllables.

Syllable	Lax (Modal)	Tense (Creaky)
Onset Consonant	Longer duration	Shorter duration
Vowel Quality	Lower F1 and F2, monophthong	Higher F1 and F2, diphthongized
Tone	Longer duration	Shorter duration
Phonation (H1-H2)	Positive (modal)	Negative (creaky)
Phonation (HNR/CPP)	High (less noise)	Low (more noise)

This pattern is consistent with Thurgood's laryngeal models, which show that laryngeal articulation, can influence the whole syllable, including vowel quality,

consonant and tone duration, and voice quality (phonation). It causes the "tense" setting in Lahu, which results in higher F1, a creaky voice, and a shorter duration. This constriction is absent in the "lax" setting, which leads to longer segmental durations and modal voice. In conclusion, this study provides acoustic evidence that the Lahu tense–lax contrast is a phonetically based syllable-level phenomenon. The results show that an integrated study of consonants, vowels, tones, and phonation types is necessary for a thorough comprehension of Lahu. Acoustic parameters such as duration, formants, harmonics, and noise-to-harmonic ratio can distinguish most tense and lax syllables, though there are individual differences. The tense–lax distinction is a property of the entire syllable, rather than a contrast confined to a single segment. Lastly, the findings presented in this study are preliminary. Subsequent research will necessitate a substantially larger sample, coupled with rigorous statistical validation.

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