Contextual Variation of Tones in Mizo

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Abstract

Mizo is a Tibeto-Burman language belonging to the Kuki-Chin subfamily and it has four lexical tones, namely, high, low, rising and falling. Contextual influence on tones of Mizo is investigated in this study. Trisyllabic Mizo phrases are recorded with the four Mizo tones in H_ H, R_R, L_L and F_F contexts. The target word is also recorded in isolation. Both carryover and anticipatory influences were found in various degrees. In case of low tone targets, preceding tones with high offset raises the target low tone. In case of rising tone targets, following tones with high onset reduce the tone to L tone. The preceding tone does not affect the target tone, in this case. Finally, the results of this study are discussed in comparison to contextual variations reported in other tone languages such as Cantonese, Mandarin Chinese and Thai.

Index Terms: Mizo, Tones, Contextual variation, Tone Sandhi

1. Introduction

1.1. Contextual tone variations

Tone languages use F0 information to distinguish meanings between words. However, tones produced in isolation have different pitch characteristics from tones produced in the context of other tones in continuous speech. Such effects from the neighboring tones are attested in studies on Mandarin Chinese, Thai and Cantonese [1, 2, and 3]. In all three languages both anticipatory and carry-over effects are attested. At the same time it is also reported that such effects differ in terms of magnitude and nature. While carryover effects in Mandarin Chinese, Thai and Cantonese are assimilatory, anticipatory effects are dissimilatory [1, 2 and 3]. It is also seen in Mandarin Chinese and Cantonese that anticipatory effects exert less effect on the tone than carryover effects. However, in case of Thai, anticipatory effects are tone dependent and limited to high and rising tones only. Thai also demonstrates that carryover effects extend beyond 50% of the following tone, whereas anticipatory effects do not extend upto 50% of the preceding tones. In light of such finding from tone languages from Asia, we would like to investigate how these findings bear upon Mizo contextual tone variations.

1.2. Mizo language

Mizo is a language of the Kuki-Chin subfamily of the Tibeto-Burman language family. It is primarily spoken in the state of Mizoram in India by about 1 million speakers. Mizo is a tone language and it has four tones, namely, high, low, falling and rising [4]. Although, tone languages have received considerable attention in the last few decades, not much is discussed about tone realization in the Tibeto-Burman tone languages. Hence, this study reports phonetics of tone realization in an understudied language, Mizo.

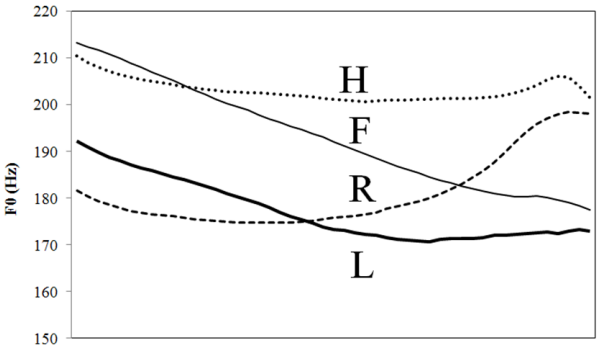

Figure 1: *Mizo tones produced by a female speaker.*

The canonical shapes of Mizo tones produced by a male speaker of Mizo in isolation are presented in Fig. 1. In the current study we would like to investigate how the canonical tones of Mizo are affected by contextual tone variations. We investigate if there is any anticipatory or carryover effect on tones in Mizo and in presence such effects, we investigate the extent of the effects on the target f0 contour.

2. Method

2.1. Material

For this study, trisyllabic Mizo phrases were recorded containing all possible combinations of Mizo tones resulting in 64 unique tone combinations. Five trisyllabic phrases for each of the 64 combinations were designed resulting in 320 phrases. Each phrase was uttered three times by the four speakers resulting in 3840 trisyllabic utterances in total. For carryover effect, four Mizo tones of the last syllables of the trisyllabic phrases were examined occurring after all possibilities of tones. For anticipatory effect, four Mizo tones of the initial syllables of the trisyllabic phrases were examined followed by all four tones in Mizo. All the phrases were grammatical and they were perceived natural by native speakers of Mizo.

2.2. Recording

Data from four native speakers of Mizo (2 male + 2 female) was recorded in the field. The speakers were from Aizawl in Mizoram and they did not report any problem with speech or hearing. Data was recorded using a Shure SM-10 head-mounted

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microphone connected to a Tascam DR 100 MK II solid state recorder. After recording, data was transferred to a personal computer for segmentation. A native speaker of Mizo annotated the data and marked the tonal boundaries based on the existence of glottal pulses in the collected speech, using Praat [4]. The time indices of tonal boundaries were written to a text file.

2.3. F0 extraction

F0 values for tone contours were extracted using the time indices specified in text files. F0 values were collected at every 2% of the total duration of the pitch contour for each tone in the trisyllabic phrases. Thus, duration for pitch contours was normalized and extracted values were written to a spreadsheet for plotting and statistical analyses. In order to produce plots of pitch contours in Mizo, the raw data with pitch calculated at every 2% of the total duration was used. Assuming gender effects, f0 plots were generated separately for male and female speakers. However, for statistical analysis, f0 values calculated at every 25% of the total duration was used.

2.4. Statistical analyses

For statistical analysis, pitch at five equidistant points along the f0 contour of the affected tone was used, namely, at onset, 24%, 50%, 76% and at the offset of the tone. Univariate Analysis of Variance (ANOVA) and Bonferroni post-hoc tests were conducted to see if there were any significant anticipatory or carryover effects on tones. While the f0 values of pitch contours of Mizo were the dependant variables, the fixed factors were tone type, tone of the preceding and following syllables and gender. Another ANOVA test was conducted for each target tone to see the extent of effects of the preceding and following tones by tone types. In this particular test, dependent variables were tones at five pitch points and factors were tones of the preceding and following syllables. This particular test was conducted with f0 values normalized for gender, as the data demonstrated gender effects when analyzed by target tone types.

3. Results

3.1. Anticipatory effects

Fig. 2 shows that the falling tones are significantly affected by the following four tones of Mizo. When the falling tone is followed by another falling tone, the effect is the least. However, following high, rising and low tones result in the lowering of the falling tone. A following high tone exerts dissimilatory effect on the preceding falling tone. However, considering the low onset of the following rising and low tones, the effects on the falling tone appears to be assimilatory.

High tones are not affected by the following tonal contexts to a great extent. However, when followed by a high tone, the offset of the preceding high tone is lowered, indicating a dissimilatory effect. However, when the high tone is followed by a falling tone it does not show any dissimilatory effects. High tones before rising and low tones demonstrate a falling contour towards the offset indicating assimilatory effects.

Rising tones appearing before high and falling tones are realized with a low level contour. This we believe, is a tone sandhi rule in Mizo. On the other hand, rising tones followed by rising and low tones demonstrate canonical rising tone shapes, even though they tend to fall towards the offset.

Low tones followed by rising and low tones show assimilatory effects and do not deviate much from the canonical low tone shapes. However, when followed by high and rising tones, low tones raise- indicating assimilatory effects. As expected statistical analysis in Table 1 showed that, at all durations of the pitch contour, tone and post-tonal onset has a significant effect. Similarly, tone and post-tonal onset together have significant interaction indicating that post-tonal onsets have distinct effects on the preceding f0 contour by tone types. On the other hand, Gender x Post-tonal onset x Tone did not demonstrate significant effects on the pitch contour indicating that gender does not influence the results of the interaction of tone and post-tonal onset.

Another statistical analysis conducted to see the extent of effect of each of the following tones showed that all tones are susceptible to anticipatory effects, except the high tone. As noticed from the high tone, following tones affect the high tone only in the final 25% of its tone contour. Apart from the high tone, all other tones are affected by the following tones at the complete 100% of their tone contour (see Table 2).

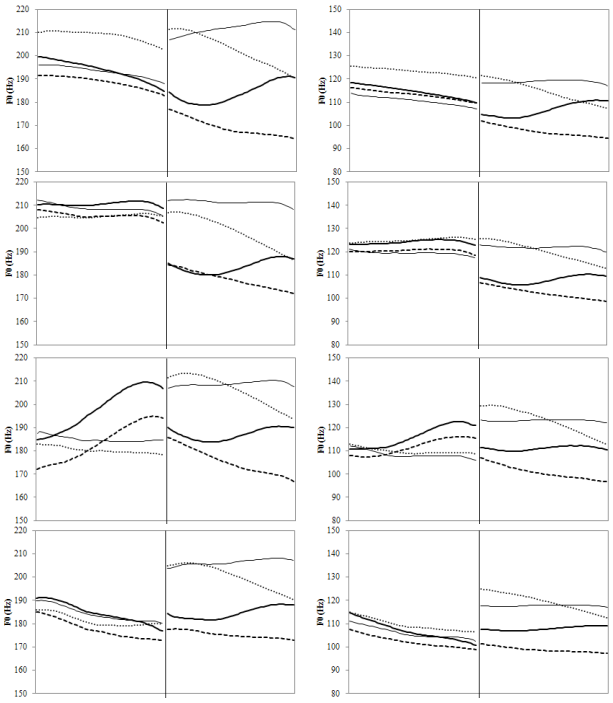

Figure 2: *Anticipatory effect of tones: from top falling, high, rising and low tones in the first syllable followed by all four tones. The left pane shows pitch contours of female speakers and the right pane shows pitch contours of male speakers. In the second syllables high, falling, rising and low tone contours are indicated by thin solid, dotted, bold solid and dashed lines, respectively.*

3.2. Carryover effects

Fig. 3 shows that the falling tones followed by falling and low tones have lower onsets. On the other hand, falling tones followed by high and rising tones have higher onsets. Hence, it can be confirmed that preceding tones have assimilatory effects on falling tones. High tones are also lowered when following tones are falling and low, indicating assimilatory effects. Again in this case, we notice that the rising tone preceding a high tone becomes a low level tone, confirming that it is a case of tone

Table 1: *ANOVA results for effects of post tonal onset, gender and tone at five equidistant ponts of the pitch contour of the first syllable*

Effect	0%	24%	50%	76%	100%
Gender x Post-tonal onset x Tone	.097	.205	.149	.419	.656
Post-tonal onset x Tone	.000	.000	.000	.000	.000
Tone	.000	.000	.000	.000	.000
Post-tonal onset	.000	.000	.000	.000	.000

Table 2: *ANOVA results for effects of post-tonal onset by tone type*

Tone	0%	24%	50%	76%	100%
Falling	.000	.000	.000	.000	.000
High	.057	.387	.408	.157	.011
Low	.000	.000	.000	.000	.000
Rising	.000	.000	.000	.000	.000

sandhi in Mizo. In case of the rising tone, high and rising tones raise the onset. On the other hand falling and low tones lower the onset of the rising tone. Tones in Mizo have assimilatory effects on the rising tone. In case of the low tone, high and rising tones raises the onsets of the following low tone. On the other hand, falling and low tones lower the onset of the low tone, again, demonstrating assimilatory effects.

Statistical analysis in Table 3 shows significant effects of tone, pre-tonal offset throughout the pitch contours of the preceding tones. Similarly, tones and pre-tonal offsets together show significant effect on the following pitch contour indicating that pre-tonal offsets have significant effect on the following pitch contour. However, as in case of post-tonal onset, Gender x pre-tonal offset x Tone did not show any significance indicating gender does not influence the interaction between pitch contour and tone and pre-tonal offset.

ANOVA test conducted to see the extent of the preceding tone on the following tones by tone types revealed that all four tones in Mizo have significant effects on the following tones. Results also showed that the effect of the preceding tones is significant throughout the following pitch contour confirming that carryover effects are spread to the whole of the following pitch. Table 4 shows the p values showing significance along five locations of the f0 contour affected by tone types of the preceding tones.

3.3. Tone Sandhi in Mizo

In secctions 3.1 and 3.2 we have observed that the Mizo rising tone becomes a low tone when followed by high onset tones, i.e. H anf F. These rising tones are perceived a low tones by

Table 3: *ANOVA results for effects of pre-tonal offset, gender and tone at five equidistant ponts of the pitch contour of the final syllable*

Effect	0%	24%	50%	76%	100%
Gender x Pre-tonal offset x Tone	.340	.306	.336	.016	.066
Pre-tonal offset x Tone	.000	.000	.001	.001	.000
Tone	.000	.000	.000	.000	.000
Pre-tonal offset	.000	.000	.000	.000	.000

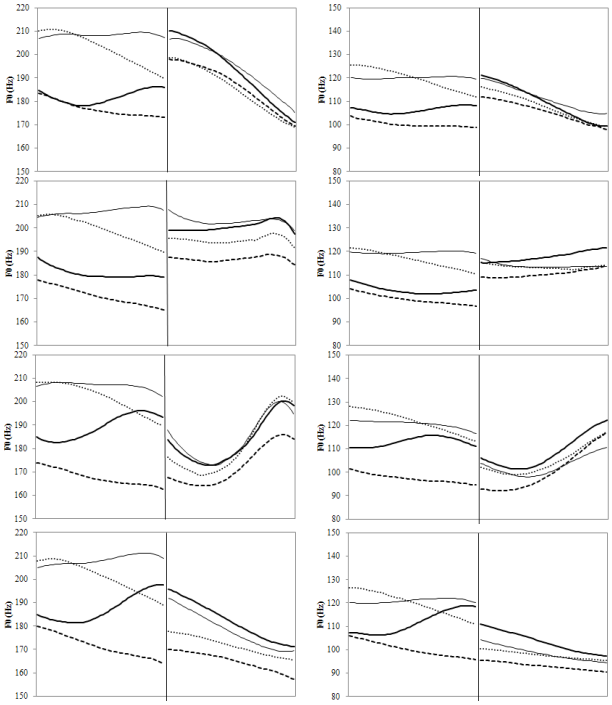

Figure 3: *Carryover effect of tones: from top falling, high, rising and low tones in the second syllable preceded by all four tones. The left pane shows pitch contours of female speakers and the right pane shows pitch contours of male speakers. In the first syllables high, falling, rising and low tones contours are indicated by thin solid, dotted, bold solid and dashed lines, respectively.*

Table 4: *ANOVA results for effects of pre-tonal offset by tone type*

Tone	0%	24%	50%	76%	100%
Falling	.000	.008	.032	.009	.004
High	.000	.000	.000	.000	.000
Low	.000	.000	.000	.000	.000
Rising	.000	.000	.000	.000	.000

native speakers of Mizo. Such phenomena are attested in tone languages like Mandarin, Thai and Kuki-Thaadow [1, 2 and 7] and are termed as tone sandhi. An often cited example of tone sandhi is from Mandarin Chinese where two falling-rising tones occuring one after another dissmilate to a rising tone followed by a falling-rising tone. The analysis of Mizo rising tone in this work provides evidence for tone sandhi in the language. The R tone in the context of a following H or F tone loses its contour and reduces to an L tone. The contour of R tone can be considered to be the combination of two register tones L and H with a low onset and high offset. This LH tone reduces to L tone when the onset of the following tone is high. However, no such tone reduction is seen when the LH tone in the context of a tone with low onset (L and R) tone. W ehave also observed that the Mizo tone sandhi rule does not apply in some cases, e.g. whenever the R target tone is followed by an F toned adverb /re/, the Mizo tone sandhi rule does not apply and the R target tone remains unchanged. This is an exception we intend to examine in our future works.

4. Conclusions

The results of this study conclude that like other tone languages, Mizo also demonstrates evidence of contextual tone variations. Contextual variations are bidirectional in Mizo, i.e. they can influence the preceding and the following tones, demonstrating anticipatory and carryover effects. In case of Mandarin Chinese, Thai and Cantonese, certain asymmetry is noticed in the extent of anticipatory and carryover effects. In case of Mizo, we did not see such asymmetry and statistical tests confirmed that both anticipatory and carryover effects extend to the 100% of the total duration of the preceding and following tones. The reason for this could be the fact that the overall height levels of the neighboring tones get affected by the tone in context.

In case of anticipatory effects, we notice that even though the overall heights of tones get affected, the shapes of the high and low tones are not affected by the following tonal context. On the other hand, due to the following tonal contexts, rising and the falling tones get considerably affected. Hence, we conclude that anticipatory effects are realized more on the contour tones than on the level tones in Mizo.

In case of anticipatory effects we noticed that the contours of dynamic tones got reduced. As claimed before [5], we notice that while contour shapes are reduced and they become flatter, their tonal onsets do not vary much.

In case of carryover effects, we notice that the shapes of the tone contours are not affected by the preceding tonal context. However, the onset of the tone is significantly affected by the offset of the preceding tone. If the offset of the preceding tone is high (for preceding rising and high tones), the onset of the following tones is raised. On the other hand, if the offset of the preceding tone is low (for preceding falling and low tones), the onset of the following tone is lower.

From the discussions in the previous sections it is clear that in case of carryover effects, the effects are assimilatory. However, in case anticipatory effects, high tones following falling, rising and high tones exert dissimilatory effects on the preceding tone. In case of low tones, they primarily show assimilatory effects. Statistical analyses show that both anticipatory and carryover effects have significant effects on the neighboring tones. These effects are visible throughout the pitch contour of the target tone.

Apart from the phonetically based coartulatory effects, Mizo also demonstrates phonologically based tone sandhi rules. In this work, we have argued for the existence of tone sandhi in Mizo. While tone sandhi has been primarily described as a language specific, syntactically or morphologically driven phonological variation, the possibility of such contextual variation due to the phonetic tendency of minimizing the articulatory efforts cannot be ruled out. In case of Mizo, we assume that tone sandhi in the language might be articulatorily motivated. However, the exceptions to the tone sandhi rules also point towards a morphologically based explanation. This is an area of investigation we intend to explore in future.

Similar to other tone languages reported in this study, Mizo also shows contextual tonal effects. Both anticipatory and carryover effects are attested in Mizo. While carryover effects in Mizo are assimilatory like Mandarin Chinese and Cantonese, anticipatory effects in Mizo are tone dependent. While high tones exert dissimilatory effects on Mizo tones, low tones exert assimilatory effects.

5. Acknowledgements

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