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The Three Way Tonal System of Sylheti

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Abstract

This study reports data collected and analyzed from 7 native speakers from a corpus of 70 Sylheti noun words. Our work shows that the loss of [+spread glottis] feature from [-voice] and [+voice] onsets have resulted in independent tone association patterns. The [-voice, +spread glottis] onset associated to a Low tone, as opposed to the tone association pattern of the voiced onsets [1]. Our study looks into the tonal pattern of Sylheti which arose from the merger of [+spread glottis] and [-spread glottis] contrast in voiceless obstruents. We built linear mixed effect models of f0 and duration to examine the acoustic factors affecting tone. We found that disyllables trigger a three way tonal contrast depending on the historical features and positions of voiceless onsets in Sylheti. The tone of the syllable spreads throughout the word rather than the syllable of origin. Word is thus reclaimed to be the TBU in Sylheti. The Mean f0 for the intercept was about 274.345 Hz which represented the High tone. It differed from the Low tone by about 75 Hz, and the Mid tone by about 25 Hz. Tone affected pitch by ($\chi 2$ (1) = 927.07, $p < 0.0001$).

Index Terms: voiceless onsets, tonogenesis, disyllables, tone

1. Introduction

Sylheti is an Indo-Aryan language. It is the main language spoken in the Surma and Kushiara valleys of Sylhet Division in Bangladesh and the Barak valley region of Assam, India. The language has been regarded as a sub-division of Bangla for long but was also considered to be phonologically and grammatically unintelligible to other Bangla dialects [2]. The Sylheti language had made great advances in its literature where a distinct script was used in administrative and religious sectors during the 6th century AD [3], [4]. The 'Sylheti Nagari' script has recently been revived for educational purposes [5]. The 'Sylheti Nagari' script matches the phonology of spoken Sylheti and consists of 5 vowels and 28 consonants and was in use in printing and publishing, especially in the Sylhet division until the independence of Bangladesh. Sylheti is structurally related both to Assamese and to the rural dialects of eastern Bengal, but with a high proportion of words derived from Persian and Arabic, and has its own distinct grammar [5]. Apart from the robust differences in the lexicon and morpho-syntactic structure, Sylheti also has a noticeably reduced inventory of phonemes as compared to its cognate languages which has led to tonogenesis in the language [6].

Our present study shows that the historical [-voice, +spread glottis] onset associates to a Low tone as opposed to the tone association pattern of the voiced onsets as established in previous studies [1]. Voiceless consonant onsets as in *p^{h}al→ɸàl *'jump (noun)'* led to a Low lexical tone in Sylheti and the onsets with [-voice, -spread glottis] consonants thus resulted in a contrastive high tone as in *pal→ɸāl *'group of animals'*. When we extended the research to disyllables, we found that this contrastive high tone associates to the lexical Mid tone in Sylheti. The study shows that in disyllables the onsets with [-voice, -spread glottis] consonants resulted in a lexically contrastive Mid tone (and not High tone) as in the word for *crooked stick*, xūṭā which was historically *kuṭa. The onsets with a historical [-voice, +spread glottis] onset of the leftmost syllable led to a lexical Low tone as in the word for *taunt*, xùṭà which was *k^{h}uṭa. The words with underlying [-voice, +spread glottis] feature in the onset of the second syllable results in a contrastive High tone as in the word for *room* which is xúṭá was *kuṭ^{h}a. The High tone followed this constraint only when the leftmost syllable had a [-voice, -spread glottis] onset for the same word. As against monosyllables which exhibit only two tones, our study of disyllables shows that the loss of aspiration contrast in different onset positions, led to three lexically contrastive tones in Sylheti. The study confirms that tone is spread throughout the word and thus word is the TBU in Sylheti as reported in earlier studies on Sylheti tonogenesis. The pitch contrast in terms of mean f0, maximum f0 and minimum f0 for the three tones was very significant ($p < 0.00001$). The significance of pitch contrast within syllables was found to be only about 3 Hz, $p = 0.1254$.

2. Background

The earlier well received studies on Sylheti tonogenesis claim Sylheti has a two way lexical tone contrast as a consequence of the merger of aspirated and unaspirated obstruents. The studies [7] on the acoustics of Sylheti phonemes reported that Sylheti has a complete absence of [+spread glottis] feature from its phonemic inventory. Gope reports that the Sylheti phonemic inventory consists majorly of fricative consonants. Gope's work shows that there is a complete absence of affricates in the language as they reduced to homorganic fricatives. For instance, he shows that *tʃ de-affricates to [s] as a result historical words like *tʃal changed to [sāl] *'roof'*; similarly the word *ʧ^{h}al changed to [sàl] *'skin'*. The voiced counterpart of the affricate *dz^{h} was reduced to [z] as in the tonal pair *dz^{h}al→[zál] *'spicy'* and *dzal→[zàl] *'net'*. The voiceless velar stop was reduced from */k/ to [x] as in the word for *'drain'*, *k^{h}al→xàl but the voiced velar [g] remained unchanged. Similarly the retroflex stops *ʈ and *ɖ have merged with the alveolar stops [t] and [d] respectively as in *paʈa→ɸā.tā 'grinding-stone' or in *ɖ^{h}al→dàl 'pour'. The dental stops [t̪] and [d̪] too remained unchanged. The studies show that onsets which did not undergo fricativization triggered tonogenesis in Sylheti as well. As fricativization did spread throughout all the obstruents in the phonemic inventory, this sound change was not considered as a factor for triggering tonogenesis in the language. Gope studies Sylheti tonogenesis with special focus on the merger of aspirated and unaspirated voiced consonants and provides an explanation for

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the introduction of the lexical High and Low tones in Sylheti. With a detailed acoustic study of lexical tone contrast in Sylheti, he postulates that the historically [+voiced, +spread glottis] onsets led to a lexical High tone as in *gáil→g^{h}ail '*beater'* (Table 1.0). The onset with [+voiced, -spread glottis] onsets thus led to a lexically contrastive Low tone as in the word *gail→gàil '*scolding*'. Thus the contrastive tones in the minimal pair *gail→gàil and *g^{h}ail→gáil are claimed as the plausible compensation of deaspiration in the language [6], [1]. The phonemic reductions by deaspiration obstruents in Sylheti in the course of its development as a language thus triggered tonogenesis.

Table 1: *Contrastive tonal pairs with voiced onsets (examples from Gope's work)*

High	Old form	Gloss	Low	Old form	Gloss
gáil	*g^{h}ail	*beater*	gàil	*gail	*scolding*
bálá	*b^{h}ala	*good*	bàlà	*bala	*bangle*
zál	*dz^{h}al	*spicy*	zàl	*dzal	*net*
ḏán	*ḏ^{h}an	*paddy*	ḏàn	*ḏan	*alms*

Previous studies have shown that pitch is the only factor that affects tone in Sylheti. The lexical tones in Sylheti were claimed to be level tones as there is a lack of pitch contour variation across syllables. The existence of lexical tone contrast in this language classifies it with a very few Indo Aryan languages like Punjabi which use tone to contrast lexical meanings. Gope predicted the existence of a third tone in his works and postulated that tonogenesis has extended beyond minimally contrastive lexical pairs and that tone has spread throughout the lexicon of Sylheti. In this study, we seek the experimental evidence of the third tone postulated by Gope, and analyze the acoustics of three-way tone distinctions as well.

3. Acoustic analysis of tonal contrast

3.1. Dataset and Recordings

We have analyzed the effects of acoustic factors which distinguish the lexical Tone contrasts in Sylheti. We have also analyzed the pitch and duration contrast and found that pitch was the only factor that predicted Tone in the language as claimed in earlier studies. The dataset was recorded and analyzed separately for monosyllabic and disyllabic words. This dataset was prepared with the help of 7 native speakers of Sylheti language residing in the Barak Valley in the southern region of Assam state in India. Two of the speakers belong to the age group 50 - 55: one male and one female; five of the speakers belong to the 20 – 26 age groups: one male, four female. All the speakers had their primary education in either Bangla or English languages. The sentences with target words were displayed on a screen along with the meaning of each word written in Bangla and English. Each target word had 3 repetitions and the words were recorded in the same carrier sentences for all words with x being the target word; carrier sentences of the SOV order were uttered as: ami '1st p' X 'target word' xɔi-si 'say-perf 1p', which meant I said X. Dataset for monosyllables had 9 minimal pairs for CVC syllabic pattern with three iterations from 7 speakers as shown in Table 2. The dataset for disyllables consisted of 5 minimal triplets, 4 individual words and 20 minimal pairs of CVCV syllabic pattern in three iterations each as shown in Table 3.

Table 2: *Dataset for monosyllabic tonal pairs with* voiceless onsets

Mid	Old form	Gloss	Low	Old form	Gloss
ṯāl	*ṯal	*palm*	tàl	*t^{h}al	*plate*
ɸāl	*pal	*animal (collective)*	ɸàl	*p^{h}al	*jump (noun)*
xāl	*kal	*bad-time*	xàl	*k^{h}al	*skin*
ɸān	*pan	*betel-leaf*	ɸàn	*p^{h}an	*yam leaf*

3.2. Statistical analysis

The f0 (in Hz) of annotated sound files extracted with the help of a PRAAT script was measured at the onset of voicing of the vowel of each target syllable. Each target syllable was measured for pitch at 11 consecutive points starting from the onset till the offset, i.e., startpitch to endpitch (0% 100%) across its duration, each point representing 10% of the total length of the pitch-track. Each data point was transformed into z-score via z-score metric. The normalized f0 value (z) was calculated as the difference between the raw f0 in Hertz (F) and the mean f0 of each subject in Hertz (μ), divided by the standard deviation of the overall f0 of the same speaker (σ).

$(z = (F- \mu)/\sigma)$.

The averages of normalized pitch values for homophonous words were drawn in contours to see the pitch variation for both monosyllabic and disyllabic word pairs. Once the pitch contrasts were established, we further strengthened our results using a linear mixed effects model – lme4 [8]. The factors selected to measure the tone contrast were the raw Mean Pitch, Maximum Pitch and Minimum Pitch (in Hz) and Duration (ms) values extracted from at the onset of voicing of the vowel of each target syllable till the offset by using the same script on PRAAT. With likelihood ratio tests [9] Mean f0, Max f0 and Min f0 had been designed as the predictors of Tone variance in this model. To test for significant effects, an anova model was run next.

Table 3: *Dataset for three way tone contrast for disyllabic words*

High	Old form	Gloss	Low	Old form	Gloss	Mid	Old form	Gloss
ɸá.tá	*pa.t^{h}a	*ram (goat)*	ɸà.ṭà	*p^{h}a.ta	*torn*	ɸā.tā	*pa.ta	*grindstone*
xú.tá	*ku.ṭ^{h}a	room	xù.tà	*k^{h}u.ṭa	*taunting*	xū.tā	*ku.ṭa	*stick*
ɸá.xá	*pa.k^{h}a	fan	ɸà.xà	*p^{h}a.ka	*empty*	ɸā.xā	*pa.ka	*ripe*

xá.tí	*ka.t^{h}i	*stick*	xà.tì	*k^{h}a.ti	*pure*			
ɸú.ʈí	*pu.ʈ^{h}i	*manuscript*				ɸū.ʈī	*pu.ʈi	*bead*
ɸá.kí	*pa.k^{h}i	*bird*	ɸà.kì	*p^{h}a.ki	*knot*			
			xɔ̀.là	*k^{h}ɔ.la	*stream bed*	xɔ̄.lā	*kɔ.la	*banana*
			sɔ̀.ɽà	*tʃ^{h}ɔ.ɽa	*stream*	sɔ̄.ɽā	*tʃɔ.ɽa	*sparrow*
						ɸɔ̄n.ʈī	*pɔn.ʈi	*great-grandchild*
ɸɔ́.ʈá	*pɔʈ^{h}a	*dawn*						

4. Results

4.1. Monosyllables

The y-axis in Figure 1 represents the speaker normalized pitch contrast and the x-axis represents the time-interval at eleven consecutive points. The underlying aspirated bilabial stop in *p^{h}an→ɸàn *'yam-leaf'* imparts a low pitch on the adjacent vowel represented by the low pitch interval points in Fig. 1 which leads to the lexical Low tone. The homophonous word *pan→ɸān *'betel-leaf'* receives a contrastive high pitch represented by the high pitch interval points in Fig. 1 which leads to the lexical Mid tone. We saw that pitch varied for the two tones throughout the duration of the vowels. Tone affected pitch ($\chi2$ (1) = 352.97, $p < 0.0001$), lowering it by 59.64 Hz for words with underlying voiceless obstruent onsets with the standard error of about 2.37. Figure 2 shows the boxplot for variation between the Mid and Low lexical tones in terms of Meanpitch. Tone is plotted on the x-axis and Meanpitch is plotted on the y-axis. Duration as a predictor of Tone was not found to have any significant effect. Low tone was lower in duration of only 3.961 (ms) and the p-value was 0.1254 which showed that the duration is not an acoustic predictor of tone in Sylheti.

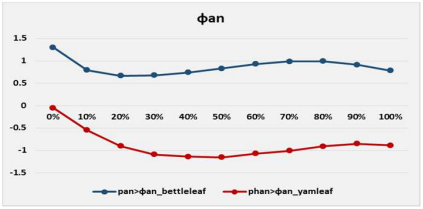

Figure 1: *Normalized interval pitch contrasts for* *p^{h}an→ɸàn *'yam-leaf' (Low) and* *pan→ ɸān *'bettle-leaf'* (Mid)

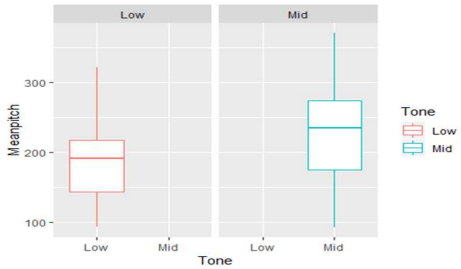

Figure 2: *Boxplot for two-way tone contrast between Mid and Low tones for monosyllables.*

4.2. Disyllables

When analyzed for the normalized interval pitch contours of the z-scored values for disyllables showed clear pitch variation for the three tones as in distinction shown in Fig.3 between *pa.t^{h}a→ɸá.tá *'ram (goat)'* and *pa.ta→ɸā.tā *'grinding stone'* and *p^{h}a.ɽa→ɸà.tà *'crack'*. We can clearly see that both the syllables maintain the contrast in pitch height for all three tones. The distinction in pitch height is thus linked to the three contrastive tones namely High, Mid and the Low tones. For the statistical contrast (Table 3) in terms of Mean pitch, the intercept was about 274.345 Hz which represents the High tone. It differed from the Low tone by around 75 Hz, and the Mid tone's difference with the High tone was around 25 Hz. Tone thus affected pitch by ($\chi2$ (1) = 927.07, $p < 0.00001$), lowering it by 74.596 Hz for Low tone and 24.816 Hz for the Mid tone with the standard error of about -30.473 and -10.267 respectively for each tone. Duration did not play any role in tone contrast ($p < 7.694e-12$). We also could not find any difference between syllables for pitch contrast. The p-value was 0.1144 and the difference between syllable 1 and syllable 2 was just of about 3 Hz, syllable 1 being represented by the intercept here which is about 254 Hz. Figure 4 shows the boxplot for tone variation in terms of Meanpitch for High, Low and Mid tones. Thus, we can say that pitch is dependent to vary only in terms of tone in Sylheti.

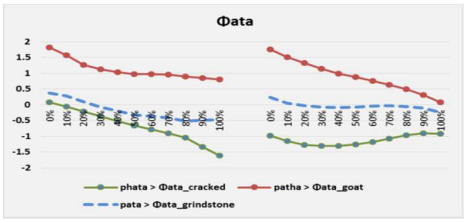

Figure 3: *Normalized interval pitch contrast for tonal triplet* *pa.t^{h}a → ɸá.tá *'ram' (High),* *p^{h}a.ta→ ɸà.tà *'crack'* (Low) *and* *pa.ta → ɸā.tā *'grind-stone' (Mid)*

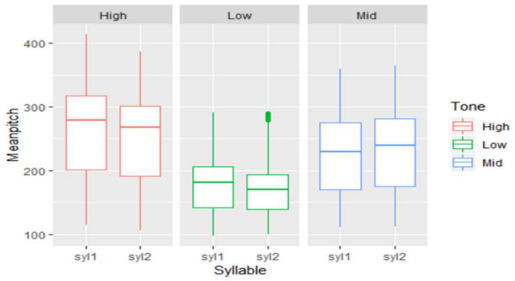

Figure 4: *Boxplot for three-way tone contrast between High, Mid and Low tones for disyllabic words*

The boxplot in Figure 4 shows that the syllabic difference for pitch is not consistent and clearly not sensitive to tone groups. In terms of Maximum pitch, The intercept was about 290.673 Hz which represents the high tone was seen to differ from the low tone by around 83 Hz, and the Mid tone difference with the High tone was around 36 Hz. In terms of Minimum pitch, the High tone was represented by the intercept of 240.139 Hz. The Mid tone was low by about 13 Hz for Min f0 and the Low tone was low by about 62 Hz. We can see the difference between the three tones in terms of Mean f0, Max f0 and Min f0 have very significant X^2 -Values and t-values and hence a significant p-value of < .00001 in the table (Table 4).

Table 4: *Fixed effects and anova results for three-way tone contrast in disyllabic words in terms of pitch*

	Fixed Effects	**Estimate**	**Std. Error**	**t-value**	**Df**	**X^2- Value**	**p-value**
Mean f0	Intercept	274.345	16.426	16.702	2	-	-
	Low Tone	-74.596	2.448	-30.473		927.07	< .00001
	Mid Tone	-24.816	2.417	-10.267			
	Fixed Effects	**Estimate**	**Std. Error**	**t-value**	**Df**	**X^2-Value**	**p-value**
Max f0	Intercept	290.673	22.192	13.10	2	-	-
	Low Tone	-83.044	2.766	-30.03		792.59	< .00001
	Mid Tone	-36.116	2.741	-13.18			
	Fixed Effects	**Estimate**	**Std. Error**	**t-value**	**Df**	**X^2- Value**	**p-value**
Min f0	Intercept	240.139	19.397	12.380	2	-	-
	Low Tone	-62.417	2.387	-26.153		785.35	< .00001
	Mid Tone	-12.645	2.365	-5.346			

5. Discussion

Tonogenetic studies have shown that it is always a reinterpretation of F0 perturbations caused by articulatory constraints during production of sounds in a language. The exaggeration of these perturbations is re-analyzed as phonological feature of the sound which contains these F0 features. The conditioning environment might be reduced or lost from the phonemic inventory of the language in this process. The assignments of contrastive tones are thought to be the consequence of this reinterpretation [10]. This is one of the most common sound changes in the languages of world which has occurred in many genetically unrelated languages [11].

The existence of tone contrast is very rare among the Indo Aryan languages. Punjabi is one of these rare languages of this family like Sylheti which uses tone to contrast lexical meanings. There have been detailed and well established studies on the tonogenesis in Punjabi which was triggered from the merger of previous laryngeal contrasts. In spite of differing analyses, all works on Punjabi tones [12], [13], [14], [15], [11], [16] conclude that tone in Punjabi arose from the merger of breathy voiced consonants with non-aspirated stops. The loss of aspiration triggered tonogenesis in Sylheti as well.

As the earlier studies and our present experiments show that tonogenesis was triggered only by the deaspiration of onsets in Sylheti, fricativization has been assumed to have taken place simultaneously with tonogenesis in the language. Thus fricativization of obstruents may not have necessarily played a role in Sylheti tonogenesis.

Our results confirm that the loss of aspiration from voiceless onsets on initial position thus led to a Low tone for both monosyllables and disyllables. The results show that while monosyllables exhibit only two tones, the loss of aspiration contrast in disyllables in different onset positions led to three lexically contrastive level tones in Sylheti. The tonal contrast emerged from the merger of [-voice, -spread glottis] and [-voice, +spread glottis] onsets of monosyllables first where [-voice, +spread glottis was interpreted as the Low tone. This led to the interpretation of [-voice, -spread glottis] as a contrastive high tone. In this study we also show with original data that in disyllables the high tone was reinterpreted as the Mid tone when the loss of aspiration contrast from the second onsets resulted in a three way contrast. To understand this, we cite the triplet [xuta] from Table 3 above. The word for *'taunting'* *k^huta→xùtà receives the inherent lexical Low tone as the leftmost onset was [-voiced, +spread glottis] and the second syllable was [-voiced, -spread glottis]. The dataset shows that words for both High and Mid tones had [-voiced, -

spread glottis] stops on the initial onsets. The historical contrast between the High and Mid tones existed only between the laryngeal features of second onsets for example in *ku.ʈa→ xū.tā *'stick'* and *ku.ʈʰa→ xú.tá *'room'*. The loss of aspiration from the voiceless onset of the second syllable in the word for *'room'* did not trigger a Low tone as expected. One argument for this could be the fact that like its neighboring Tibeto-Burman languages [17], Sylheti is a tonal language with left-alignment. The tone of the first syllable or the leftmost syllable generally spreads to the word in Sylheti [1]. The inherent tone of the leftmost syllable in the word for *room*, xútá is high as the onset was [-voiced, -spread glottis], but the contrast with the word for *stick*, xūtā which had the similar features in its leftmost onset as well. It was difficult to maintain the contrast with the homophone when aspiration was lost in the second syllable. Thus words with [-voice, -spread glottis] onset in the leftmost syllable and [-voice, +spread glottis] onset in the second syllable were reinterpreted as the High tone to maintain the contrast with the previously assumed High tone which had [-voiced, -spread glottis] onsets in both syllables.

The earlier and present studies on Sylheti tonogenesis show that Sylheti had two-fold aspiration merge due to two different laryngeal classes. Keeping the earlier studies [1], [5], [7] on Sylheti tonogenesis in mind, we could conclude that the underlying [-voice, + spread glottis] resulted in tone lowering, and [+voice, +spread glottis] resulted in a tone rise separately in the language. We propose in this study that the underlying [+voice, +spread glottis] feature of initial onsets was interpreted as the lexical High tone first in the language. The assignment of Low tone to [+voiced, -spread glottis] was consequence of reinterpretation of the lexical tone assignment and tonogenesis in Sylheti to maintain the lexical contrast. The assignment of Low tone for [-voiced, +spread glottis] emerged in the language simultaneously leading to the reinterpretation of the Mid and High tones in the language. One explanation for this could be the lowering of F0 in following vowels, due to the lower trans-glottal pressure at vowel onset after voiceless aspirated stops than after voiced stops [18], [19]. The emergence of tones in Sylheti after the loss of aspiration feature in the course of its development might be an areal feature. This could be the result of the prolonged proximity to the indigenous speakers of the Tibeto-Burman group who use Sylheti as a medium of communication in some regions [6]. It would be interesting to study Sylheti lexical tones keeping aside the minimal pairs and triplets. This could give a wider picture of the lexical tonal system of Sylheti.

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