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Tonal Alignment and Prosodic Word domain in Boro

Kalyan Das[1], *Shakuntala Mahanta*[1]

[1] Department of HSS, Indian Institute of Technology Guwahati, India
d.kalyan@iitg.ernet.in, smahanta@iitg.ernet.in

Abstract

This paper discusses the way morphological factors influence the distribution of lexical tones in Boro. Another objective of this paper is to unravel the underlying tonal nature of various prefixes and suffixes that participate in these processes. Boro is a tone language belonging to the Tibeto-Burman group. The language lexically distinguishes L and H tones. The TBU in Boro is the syllable and the lexical tone surfaces on the rightmost syllable both in derived and non-derived disyllabic words (Sarmah, 2004). The study presented here is based on data collected from 5 male speakers of Boro. The data set consisted of 175 scripted sentences containing the target words. The sentences were analysed by extracting their pitch contour using the software- Praat5.3.04_win32 (Boersma and Weenink, 2012). Results show that tonal specification of the affixes in Boro is related to a minimally disyllabic stem condition. Suffixes surface with their tone when they follow a disyllabic stem. Otherwise they surface with the lexical specification of the stem itself. This paper tries to show how a minimally disyllabic prosodic word domain condition regulates the occurrence of tones in Boro. This paper also tries to describe the prosodic status of derived and non-derived words in Boro.

Index Terms: tone, affixation, alignment, prosodic word

1. Introduction

Boro belongs to the Tibeto-Burman family of languages and it is spoken in the North-East part of India. Most researchers on Boro agree on the point that Boro is a tone language. Boro uses lexical H and L tones with the L sometimes [1] seen as a default Mid tone. The tone bearing unit (TBU) in Boro is the syllable [1] and the tonal organization is such that in disyllabic words only the rightmost TBU can bear the lexically distinct tone.

The nature of interaction between tone and morphology in Boro has been dwelt upon in some details by Bhattacharya [2], Weidert [3], and Joseph and Burling [4]. According to Bhattacharya [2] whenever a suffix is added, the root is assigned a mid tone. Weidert [3] shows that the high tone of the root is assigned to a toneless suffix after affixation. Sarmah [1] describes that Boro toneless TBUs receive the tonal specification of the stem when they are added to monosyllabic stems. This kind of disyllabic derived words in Boro conform to the tonal pattern of disyllabic non-derived words where the rightmost TBU is specified with a tone [1]. In addition to this, the study by Sarmah finds that the causative suffix '-ho' in Boro is underlyingly specified for a low tone and it retains its tonal specification after affixation. This process however does not change the tonal specification of the stem and thus the process of '-ho' affixation results in the derived word surfacing with the lexical tones of both the stem and the suffix. This study tries to enumerate the details of tone and morphology interaction in relation to various kinds of morphological processes allowed in Boro. The objective of this paper is to evaluate the underlying tonal nature of the prefixes and suffixes that participate in the following morphological processes in Boro: Tense-Aspect affixation, Number affixation, Case marking affixation, Negative affixation, Adjective forming affixation and Causative verb forming affixation. The second objective of this paper is to elucidate the nature of tonal alignment in Boro in connection with the various inflectional and derivational processes mentioned above. The processes of word formation considered for this experiment do not form an exhaustive list since Boro uses a huge variety of affixes which are added mostly to monosyllabic stem, which are not free morphemes [2][5][6]. Thus Boro vocabulary consists mostly of inflected or derived disyllabic forms with very few monosyllabic stems surfacing in the language as independent words. This experiment is designed with the assumption that the phonological properties of the affixation processes discussed here would throw some light on what might be the possible tone system in Boro.

2. Methodology

The data collection process for the experiment has been controlled by the aim of understanding the pattern of lexical tones in Boro. For this, the pitch on the rhyme of a syllable is considered to be the indicator of the underlying tone of the word or affix under consideration. Since Boro has two lexical tones: High and Low, it was thought to be important to evaluate the morpho-phonological properties of tonal interaction of stems with both H and L tones with various affixes used in the language. With this in view, the native speakers of Boro were asked to pronounce the target words placing them in the sentence frame given in (1) so that their tonal specification can be acoustically established:

àŋ_____	bùŋ-duŋ-mun	(1)
I	say-PTV-PST	
I _____	said.	

2.1. Materials

This experiment aims at describing the pattern of the tone and morphology interaction in relation to six categories of affixation allowed in Boro. Also, each category of affixation in Boro is executed by several lexical variants. With this in mind, a data set consisting of the words in Table 1 and the affixes that are allowed to occur with them are used for this experiment. The adjective forming and causative verb forming prefixes in Boro copy the vowel of the stems they precede.

2.2. Participants and Recording

Five male speakers of Boro were asked to produce the target words embedding them in the sentence frame in (1). The speakers were between 22-28 years of age. The experiment was carried out in a quiet environment in Bhatipara, Kazigaon and Bashbari villages situated near Kokrajhar of Lower Assam

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in India. Each of the speakers was paid a small fee for their participation. According to Basumatary [6] the Western Boro variety spoken in the districts of Kokrajhar, Dhubri and Chirang is recognized as the standard form the Boro language. From this viewpoint the data collected for the present experiment can be described as from the standard variety of Boro.

The speakers produced 6 iterations of each carrier sentence (the initial iteration was left out from the analysis) with sufficient pause in between. The subjects were asked to read aloud the sentences written in Devnagiri script. The speakers knew the intended meaning of the words they were about to pronounce. The subjects were also reminded about the meanings in the form of an Assamese translation after each iteration. A unidirectional head-worn microphone connected with Edirol Roland R-09HR via xlr jack was used for the recordings. The recordings were digitized at a sampling frequency of 44.1 kHz and 32 bit resolution.

Table 1: Stems and affixes used in this experiment. Stems with both H and L tones have been part of this experiment and the Words column for each affix category is divided into two segments with the words in upper segment having lexical H specification.

Affixation	Words	Prefixes	Suffixes
Tense-Aspect	tʰaŋ 'go'		-ɯ, -gɯn, -gou, -bai, -dɯŋ, -dɯŋmɯn
	lɯŋ 'drink'		
Case Inflection	dao 'bird' hatʰai 'market'		-a, -kʰou, -ao, -nɯ, -ni, -niao, -dʒɯŋ
	dɯi 'water' maozi 'cat'		
Plural Inflection	nɯŋ 'you'		'-pʰɯr' '-mɯn' '-sɯr'
	gotʰo 'child'		
Negative Affixation	tʰaŋ 'go'		'-a' '-akʰɯi' '- lia'
	pʰɯi 'come' lɯŋ 'drink'		
Adjective Forming Affixation	za 'eat' suŋ 'short' hai 'shorten' pʰe 'intoxicate'	'gV'	'-kʰor' '-dɔ' '-dɯb' '-braŋ' '-brɯm' '-lu' '-deŋ' '- tʰi'
	lɯŋ 'drink' si 'to wet' ham 'become good' su 'become cold'		
Causative verb forming affixation	go 'escape' gab 'cry' zɯb 'finish'	bV-, pʰV-, sV-	'-hɯ'
	tʰab 'fasten' mao 'do'		

2.3. Data Analysis

Each iteration of the individual words were first extracted and saved as separate wave files using the speech analysis software- Praat 5.3.04_win32. Individual sound files of the words were further segmented into the phoneme level and Praat TextGrid files were created for each of the words for acoustic analysis. The segmented files were processed with a Praat Script [ProsodyPro] for obtaining measurements of F0. This script provides various measurements of individual wave files such as time-normalized F0 where the F0 in each interval is divided into the same number of points (default = 10), and thus the points 1-10 belong to the first interval and the points 11-20 to the second interval and so on. The script also provides values for mean F0, maxF0, minF0, duration and so on. The averaged normalized F0 values of all the iterations of each word (5 speaker x 5 iterations = 25) were plotted as a line graph in order to observe the difference between the pitch contours of the words before and after affixation.

3. Results

3.1. Affixation and tonal alignment

One of the objectives of this experiment has been to examine the nature of pitch contour with which tonal minimal pairs are pronounced in Boro. Results show the nature of the pitch contours in the two lexical tones in Boro. Tonal minimal pairs examined in the present study show rising pitch contour when the word is spoken with High lexical tone. It was found that the Low tone in Boro displays falling contour, but it is sometimes expressed with low level pitch and sometimes with a falling pitch irrespective of the length of the TBU. However, tonal alignment vis-à-vis word formation processes examined here has revealed some interesting phonological properties of the language. Sarmah [1] has already shown that the lexical tone aligns to the rightmost syllable in derived disyllabic words in Boro. Results for the present experiment have shown that the lexical tone shifts to a toneless suffix only when it is attached to a monosyllabic stem. When the suffix is attached to a disyllabic stem, the lexical tone undergoes spreading. Figure 1 presents an example of this. The mean F0 of the vowel in nɔ́ 'home' (155.25 hz) is lowered (137.63 hz) when the Locative marking suffix '–ao' is added and the suffix in nɔ-aó is pronounced with a higher pitch (meanF0 = 150.60 hz, n=20). However the TBU in hatʰaí 'market' (meanF0= 168.97 hz) is not lowered drastically when the same Locative suffix is added. The mean F0 of the second syllable in hatʰaí-aó 'market-Loc' is 158.77 hz compared to that of 165.90hz for the third syllable (n=20). This distinction between tonal alignment and phonetic interpolation to the right edge, depending on the length of the stems, does not show in a prominent way when the stems have Low tones.

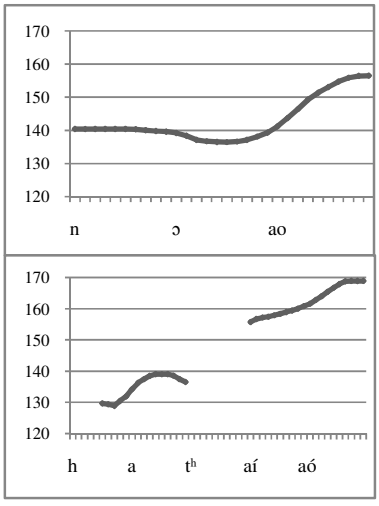

Figure 1: Averaged time normalized pitch contours (n=25) in Hertz for nɔ-aó 'house-Loc' in the upper panel and hatʰaí-aó 'market-Loc' in the lower panel. 10 points for each segment is shown.

3.2. Affixation and Dominance relationship

The nature of interaction between lexical tones and the processes of affixation considered for the present study make a strong claim for explaining it in terms of dominance relationship [7]. The term 'dominance' has been used by Kiparsky [8] to describe affixes which idiosyncratically cause the deletion of structure, usually tone or stress, from the base they attach to, often, but not necessarily substituting a new pattern in place of the deleted material. 'Recessive' affixes do not cause such deletion [7]. The various tense-aspect marking, plural marking and negative marking suffixes in Boro do not posses any lexical specification and they fall into the recessive category as is shown in (2). Their affixation follows the pattern of tone shift and tone spreading presented in Figure 1.

tʰáŋ 'go'	lùŋ 'drink'	(2)
tʰaŋ-dúŋ	luŋ-dùŋ (Perfective)	
tʰaŋ-dúŋ-mún	luŋ-dùŋ-mùn (Perfective-Past)	
tʰaŋ-á	luŋ-à (Negative)	
tʰaŋ-á-kʰɯí	luŋ-à-kʰɯì (Perfective-Negative)	

The results have also revealed that some of the prefixes and suffixes in Boro possess their lexical tone and they alter the tonal specification of the stem itself. The causative verb forming and the adjective forming prefixes in Boro are found to be of dominant nature as far as tonal alignment is concerned. Figure 2 presents an example of it. It can be seen that the Low tone of the prefix surfaces on the stem after affixation in ga-haì 'low'. Table 2 presents a list of derived adjectives where the lexical Low tone of the prefix lowers the pitch of the stem itself as a result of affixation. Table 3 presents some of the instances of causative verb formation in Boro where affixation alters the lexical specification of the stems.

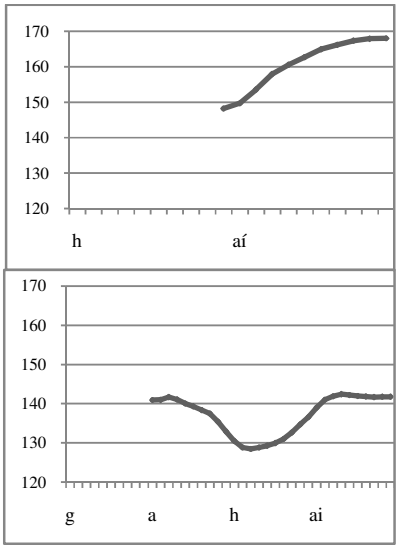

Figure 2: Averaged time normalized pitch contours (n=25) in Hertz for haí 'shorten' in the upper panel and ga-haì low' in the lower panel. 10 points for each segment is shown.

3.3. Disyllabicity and tonal alignment

In addition to the dominant prefixes discussed above, Boro also have some suffixes which have lexically specified tones and monosyllabic stems have a nullifying effect on their tonal specification. When these suffixes are added to monosyllabic stems the derived words surface with the lexical tone of the stems aligned to the second syllable. On the other hand, in the presence of disyllabic stems the derived words surface with both the lexical tones of the stem and that of the suffix. Figure 3 presents the pitch contours for aŋnì 'I-Gen' in the upper panel where the Low specification of the stem moves rightward and the Genitive suffix surfaces with a low pitch. In contrast to this, the pitch contour of bɯrmàní 'goat-Gen' in the lower panel shows how the Genitive suffix surfaces with its High specification after a disyllabic stem with a Low tone. (3) presents some more examples of the interaction of tone bearing suffixes with monosyllabic and disyllabic stems.

dɯì 'water'	dɯikʰoù 'water-Acc'	enzòrkʰoú 'rat-Acc'		(3)
dìn 'day'	dinkʰoù 'day-Acc'	bedòrkʰoú 'meat-Acc'		
bàr 'wind'	barà 'wind-Nom'	maozìá	'cat-Nom'	
dɯì 'water'	dɯi-à 'water-Nom'	gotʰòá	'child-Nom'	
àŋ 'I'	aŋnì 'I-Gen'	enzòrní	'rat-Gen'	
		hazùní	'hill-Gen'	
àŋ 'I'	aŋbù 'I-also'	muìàbú	'yesterday-also'	
		bedòrbú	'meat-also'	

However, the causative verb forming suffix '-hù' is found to be preserving it lexical Low tone irrespective of the length of the stems to which is attached. This is similar to the behavior of '-ho' reported in Sarmah [1]. The examples in (4) show it.

gí 'to fear'	gíhù 'to make frightened'	(4)
maò 'do'	maòhù "to cause an action'	

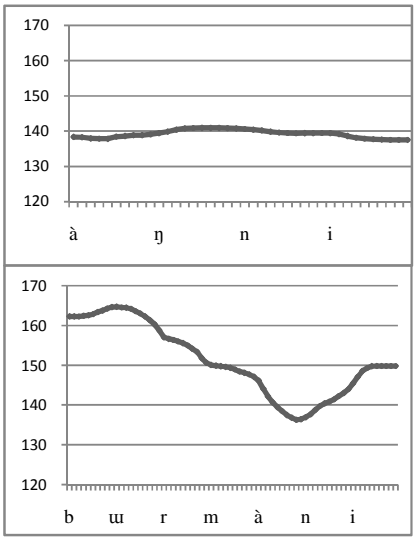

Figure 3: Averaged time normalized pitch contours (n=25) in Hertz for aŋnì 'I-Gen' in the upper panel and bɯrmàní 'goat-Gen' in the lower panel. 10 points for each segment is shown.

Table 2: Examples of Adjective formation by adding the prefix 'gV' where 'V' copies the vowel of the stem and the L tone of the prefix surfaces on the stem.

Verb	Adjective
pʰúr 'whiten'	gupʰùr 'white'
sú 'become cold'	gusù 'cold'
zí 'to tear'	gizì 'torn'
sì 'to soak'	gisì 'wet'
zén 'lose'	gezèn 'loser'
hàm 'become good'	gahàm 'good'

Table 3: Instances of causative verb formation by prefixing 'bV-, pʰV-, sV-' where 'V' copies the vowel of the stem and the Low tone of the prefix surfacing right aligned in the derived form.

Verb	Causative Verb
gáb 'cry'	sɯgàb 'to make cry'
tʰàb 'fasten'	sɯtʰàb 'to cause to fasten'
zúb 'finish'	pʰɯzùb 'to make finish'
zàm 'old'	pʰɯzàm 'to make old'
haí 'shorten	pʰahaì 'to make low"
zír 'examine'	bizìr 'to examine'

3.4. Disyllabicity and Prosodic Word domain

The nature of tonal alignment vis-à-vis word formation processes in Boro can be explained by proposing a prosodic domain for the phenomenon of tone shift, tone spreading and tone deletion. A further feature of minimality condition can be invoked to explain the phenomenon of some of the exceptional cases that fall outside of the prosodic domain aspect. The prosodic domain relevant here is that of the Prosodic Word (henceforth PrWd) which has been defined by many studies as the domain for the interaction between word formation and various phonological processes like pitch accent assigning [9], surfacing of contrastive tone [10], assigning primary stress in Greek [11]. The correspondence between syllable length and prosodic word domain has been discussed in relation to other languages too [9], [10] and [12]. The domain of PrWd in Boro seems to be the playing ground for the surfacing of the underlying tonal specifications. Sarmah [1] has already proposed such a domain for the occurrence of lexical tones in Boro in the post-affixation stages. It has been proposed that suffixes in Boro having their own lexical specification, forms their own PrWd domain. The results of the present experiment show that PrWd domain in Boro is minimally disyllabic, and only one lexical tone can surface within this domain and it is right aligned. It is due to this PrWd domain constraint that lexical tone bearing suffixes surface with the tone of the stem when they are attached to monosyllabic stems (Figure 3). This disyllabic PrWd domain explains the phenomenon of the rightward shift of the tone of the dominant prefixes in Boro as shown in Figure 2. The disyllabic PrWd domain allows disyllabic stems to preserve their lexical tone even when a toneless suffix is added to them. The tone then spreads rightward in the next level of PrWd construction. In other words PrWd structure in Boro is applied recursively [13]. Recursivity allows the Nominative suffix to surface with its own lexical specification in gotʰòá 'child-Nom', which forms a recursive PrWd domain. However unlike in the case of hatʰaíaó 'market-Loc', the lexical tone of the stem does not spread rightward as the suffix is already specified with its lexical tone. The representations in (5) summarize the distribution of lexical tones in Boro PrWd domains. The specifications within brackets refer to lexical tone and the vacant space refers to a toneless unit.

Prefix (L)+Stem (H)=[_ L]$_{PrWd}$ (5)
[gV + zí] = [gizì] $_{PrWd}$ 'torn'

Stem (L)+Suffix (H) = [_ L] $_{PrWd}$
[àŋ + ní] = [aŋnì] $_{PrWd}$ 'I-Gen'

Stem (__ H)+Suffix (__) = [[__H] $_{PrWd}$H] $_{PrWd}$
[hatʰaí + ao] = [[hatʰaí] $_{PrWd}$ aó] $_{PrWd}$ 'market-Loc'

Stem(__L)+Suffix (H) = [[__L]] $_{PrWd}$H] $_{PrWd}$
[hazù + ní] = [[hazù] $_{PrWd}$ ní] $_{PrWd}$ 'hill-Gen'

However the causative verb forming suffix '-hù' presents a case where a tonally specified suffix does not adhere to the rightward tone alignment rule within PrWd. It seems '-hù'is marked as a prosodic word in the lexicon itself as has been the explanation for similar behavior of some suffixes in Dutch [14]. It is because of this reason the causative suffix shows some amount of idiosyncrasy and surfaces with its lexical specification when it follows a monosyllabic stem. With this suffix forming its own PrWd, forms like maòhù 'to cause an action' constitute a recursive PrWd domain in Boro.

4. Conclusions

The description of tonal alignment vis-à-vis affixation in Boro shows that PrWd is the domain for the lexical tones to surface in the language. The PrWd domain is minimally disyllabic and this is marked by a lexical tone aligned to its right edge. Prefixes adhere to this process of tonal alignment within a disyllabic frame. Suffixes with lexical tones also adhere to this process of boundary alignment within this PrWd domain. Suffixes form recursive PrWd domain when they are added to disyllabic stems. Both tone bearing and toneless suffixes form this recursive PrWd domain and the boundary association condition is fulfilled by spreading from the right edge of the minimum disyllabic PrWd domain to a toneless suffix occurring at the right edge of the recursive PrWd domain. However, with suffixes having lexical specification such spreading is not encouraged since the right edge of the recursive PrWd domain is already associated with a lexical tone. Example of lexical tone migrating from the root to the right edge can be found in Digo [15][16]. Bickmore [17] and Bickmore and Doyle [18] reports that lexical tone can spread to the right in Chilungu verbal paradigms where an underlying H spreads rightward in an unbounded fashion, subject only to word-final extra-prosodicity. Thus tone spreading to the right has been looked at in the relevant literature as a natural process [19]. Sometimes tone spreading is local, taking in just one extra syllable, and sometimes it is unbounded, covering any number of available target syllables [15]. Tones may also migrate to the penultimate syllable as a result of affixation [20]. In the description of tone systems, PrWd has also been identified as the domain for the phonological process of tone assignment in some languages [21]. However, Boro allows tones to migrate to the right edge only in a disyllabic PrWd domain. As a result of this, spreading shoulders the burden of tonal association to the following syllable if such a syllable is not lexically specified with a tone. Thus, spreading to the right edge occurs in the recursive PrWd domain. In fact, the disyllabic PrWd domain in Boro can be considered to be the basic lexical unit for any lexical tone to surface.

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