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RESEARCH

Intonational phonology of Boro

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The pitch contour of an utterance in a tone language can surface with both tonal and intonational f_0 features. In this paper we set out to analyze the intonational phonology of Boro, a tone language, and establish that there are three levels of prosodic constituents in Boro: Prosodic Word, ip and IP. Prosodic Word is the domain for distribution of lexical tones. Phonological processes show that the next higher level of prosodic structure is that of the intermediate phrase. Downstepping is within intermediate phrases (ip) and does not cross ips. The highest level of prosodic constituency is the IP which is marked by both initial and final boundary tones. This study shows that in Boro intonational phonology, boundary tones and their scaling and alignment in the context of their lexical tones is more important than assigning pitch accents.

Keywords: Boro; intonation; prosodic organization; intermediate phrase; downstepping

1 Introduction

Boro[1] is a Tibeto-Burman language predominantly spoken in many parts of the Brahmaputra valley of Assam and also in some parts of West Bengal in India. The language is also known as Bodo (Hodgson 1847; Grierson 1903). The language has been described as vulnerably endangered by UNESCO Atlas of the World's Languages in Danger 2010, which is the lowest level of endangerment for any language. However, Boro is spoken by a large number of people and the number of Boro speakers in Assam in the 2011 census is 14,82,929[2] (1.4 million) and it is officially recognized as one of the scheduled languages by the Government of India, the only Tibeto-Burman language to attain national recognition.

1. 1 Tone in Boro

Understanding the distribution of lexical tones is an important aspect in the description and analysis of tone systems. Most researchers agree that Boro is a tone language (Weidert 1987) and that Boro uses lexical High and Low tones and sometimes a default Mid tone is also assumed (Sarmah 2004). These tones can be employed to distinguish lexical meaning of Boro words as in (1) below (Sarmah 2004):

(1a) [gaó] 'tear or split'
(1b) [gaò] 'shoot by arrow or gun'

[1] In terms of nomenclature, both Bodo and Boro are equally prevalent. The influential Bodo Sahitya Sabha (Bodo Literary Society) has approved the use of both Boro and Bodo to name the language. Many past and recent studies on the language like Burton-Page (1955), Bhat (1968), Bhattacharya (1977), Joseph and Burling (2001, 2006), Basumatary (2005), Boro (2007) and DeLancey (2010, 2011) have described the language as Boro. In this paper, we follow the name frequently used in these works on Boro and therefore use Boro.

[2] Retrieved from http://www.censusindia.gov.in/2011Census/Language-2011/Statement-4.pdf on 10th July 2018.

The tone bearing unit (TBU) in Boro is the syllable and the rightmost TBU hosts the lexical tone in disyllabic words. Joseph and Burling (2001) reiterate the view expressed in Burling (1959) and come to the conclusion that Boro has a two-tone system. In addition to this, Joseph and Burling (2001) also mention the presence of the phenomenon of tone spreading in Boro towards the right. Joseph and Burling (2006), while presenting a description of the comparative phonology of the Boro-Garo languages, reiterate Joseph and Burling (2001) by describing a two-tone system for Boro. They found no evidence for the four tones claimed by Bhattacharya (1977). Bhattacharya (1977) focused mainly on the tone pattern in monosyllabic words, but other studies have shown that Boro disyllabic words can have only one of the two tone patterns, whether it be a High tone or a Low (Joseph & Burling 2006). Sarmah (2004) presents further evidence to show that Boro has two tones: High and Low. Extensive discussion of Boro tones can be found in Das & Mahanta (2018), and Das (2017).

In our discussion in the following sections we do not claim that Boro is a densely tone marked system. It could be close to what Voorhoeve (1973) describes as a 'restricted tone system'. Notably we do not make any proposition regarding its adherence to a pitch-accent system as there are no clear properties that a pitch-accent language attests. Hyman (2009: 213) notes "… alleged pitch-accent" systems freely pick-and-choose properties from the tone and stress prototypes, producing mixed, ambiguous, and sometimes analytically indeterminate systems which appear to be "intermediate". Hyman presents a rigorous discussion arguing for the absence of any pitch-accent prototype, nor can prosodic systems be treated as a continuum placed along a single linear dimension. As far as Boro is concerned, apart from Hyman's arguments, the attributes of stress are also not entirely clear and therefore Boro is not amenable to an analysis as a pitch-accent language where lexical tone is delimited to the vicinity of the stressed syllable.

In the following section, we attempt to look at a few delimiting properties of intonation across these types of languages in order to see if there's indeed a pattern for such restricted tone languages. It appears that there are indeed intonational properties common to languages which attest lexically distinctive f0, whether restricted or not, and they may allow more intonational properties to appear but there are no fixed ways in which they can be predicted to show their intonational and prosodic effects, making it more difficult to classify these languages.

Section 1 describes the distribution of tones in Boro. Section 2 deals with the domain of prosodic word as the domain of tone assignment in Boro. Section 3 describes the methodology adopted for the experiments presented in the chapter and the speech material designed for the experiments. Section 4 highlights the way lexical tones surface at the sentence initial, medial and final positions. It also describes the basic intonation patterns in Boro and shows how downstepping and declination influence lexical tones. This section also shows how left edge boundary tone influences initial lexical tones in IPs. Section 5 presents a phonological account of intonation in Boro, based on the nature of prosodic phrasing allowed in this tone language. This section also highlights the fact that the left edge of Boro IPs are marked by an LH% boundary tone which interacts differently with the initial L and H lexical tones. Section 6 discusses the attributes of the Intonational Phrase in Boro. Section 7 summarizes the findings presented in this paper.

1.2 Tone and intonation in tone languages and pitch accent languages

The question whether tone languages and 'pitch accent' languages vary in terms of intonation does not lead to any forthrightly viable answers. This is because both tone languages, and the languages commonly identified in the literature as pitch accent languages, not only attest intonational properties which are seen in intonation only languages, but also show deviations which are not particular to any of these groups.

Just like tone languages, pitch accent languages like Swedish and Norwegian, have simpler intonation systems than, for instance, English, a language without lexical tone (Gussenhoven & Vliet 1999). The segmental site for tone-intonation interaction in Venlo Dutch, a language variety that distinguishes two lexically distinctive tonal accents, is the IP final syllable where the boundary low tone (L%) spreads leftward to a free TBU (mora) to generate two L targets at the right edge (Gussenhoven & Vliet 1999). Similar to these languages, certain Oto-pamean languages of Mexico, like Shekgalagari, restrict their lexical tone contrast to pre-final syllables reserving word-final syllables for intonational contrasts (Hyman & Monaka 2011). In Shekgalagari, the L% lodges itself on the penultimate syllable where penultimate lengthening lends a second mora for L% association. The lexical high tone in Kikuyu undergoes flattening when it is followed by L% (Clements & Ford 1981). In Mayen Franconian, the final L of the HL% question tone is truncated when it is preceded by an L* and a H tone in the same syllable (Gussenhoven 2000).

Prosodic boundaries may be inserted before or in the vicinity of the focused constituent (Hartmann 2008). This is true for both 'pitch-accent' and typical tone languages. The relationship between focus and phonological phrasing is well known in Japanese (Poser 1984), Hausa (Inkelas 1998), Korean (Chao 1990), Modern Greek (Condoravdi 1990), and Shanghai Chinese (Selkirk & Shen 1990). Kanerva (1990) describes how narrow focus within the verb phrase in Chichewa results in an increase in the number of p-phrases. When only the verb is placed under narrow focus, a phonological boundary forms after the verb in the verb phrase. The entire verb phrase forms one p-phrase when the whole VP is focused. Downing (2006) describes the focus marking strategy in Chitumbuka (Chitumbuka has restricted tone, like Boro) and highlights how prosodic phrasing marked by lengthening of the penultimate syllable of the focused constituent marks a constituent prominent. Downing (2008) demonstrates how in Chichewa, Chitumbuka and Durban Zulu, phonological rephrasing functions as the prosodic correlates of focus. Thus, analyzing the tonal system of a language without taking into account the intonational structure may result in incomplete understanding of the data (Gussenhoven 2012). The integration of lexical and intonational tones played an important role in the description of Japanese in the work by Pierrehumbert and Beckman (1986), and later in that of Norwegian, varieties of Basque and Dutch dialects (Gussenhoven 2002).

Another aspect where there's a lot of overlap among languages pertains to boundary tones. Boundary tones (Pierrehumbert 1980) are distinguished from other tones by their distribution. These tones generally appear on the edgemost syllable of a domain, such as the last syllable of an IP. They differ from lexical tones in having a phrasal distribution and their functional presence may be seen as a means to distinguish sentence types (Myers 2004). Boundary tones often have a strong effect on the f0 scaling of other tones in the utterance. In Chichewa, the f0 values of lexical high tones are markedly higher in questions than in statements (Myers 1996). f0 peaks are higher in questions than in statements in languages as diverse as Mandarin (Ho 1977; Shih 1987), Russian (Svetozarova 1975), Swedish (Gårding 1979), Vietnamese (Nguyen and Boulakia, 1999), Kikuyu (Clements 1981), Jita (Downing 1995) and Hausa (Inkelas & Leben 1991). Another important point has emerged in the discussion of boundary tones in tone languages as well as in pitch-accent languages, that is, boundary tones can sometimes migrate away from the originating boundary, as shown by Hyman (1990) for Luganda super-high tones, and by Gussenhoven (2000) for Dutch. The LHLH string marking accentual phrase is Seoul Korean is reduced to just an initial LH if the accentual phrase consists of three syllables

(Jun 1993; 1998). Accentual phrases in Northern Bizkaian Basque are characterized by an initial pitch rise due to a sequence of LH tones where the target of L occurs on the first syllable and the H aligns to the second syllable (Gussenhoven 2004). In Northern Bizkaian Basque the realization of the LH initial boundary sequence depends on the availability of syllables. Neither of the initial L or H boundary tones surface when the first syllable is occupied by H*. In instances of H* surfacing on the second syllable, only the L boundary tone of the LH sequence is realized (Gussenhoven 2004).

Boro shows a mix of the properties outlined above. While tones are not deleted to allow for more intonational tones (except the final H) to appear, there are indeed other intonational characteristics of note. They include a left edge boundary tone of LH% which is especially pronounced if there's a lexically specified low tone at the left edge (showing some similarity with Basque but not entirely), deletion of a final H tone, and tonal scaling of H tones vis-à-vis the presence of other H and L tones. Downstepping is also widely attested and these downstepped tones serve as cues to prosodic boundaries in the nature of their distribution. More research on intonation in tone languages, restricted or otherwise, will help us to understand if certain types of tone languages exhibit these intonational properties. Till then it is safe to say that Boro intonation shows adaptive behavior and restricts deletion of underlying tones but does create additional tonal targets.

2 Boro Tones: interplay of morphology and prosody

Das & Mahanta (2018) present a detailed description of the role of morphology in constraining tonal alignment in Boro. This section highlights some of the main properties related to prosody and morphology. Boro tones undergo tone shift, tone spreading and tone deletion in morphologically derived domains. It has been noticed that a lexical tone in Boro can shift from the initial position to the second syllable to align to the right edge of a derived word. But the lexical tone cannot shift from the second syllable to the next one irrespective of the word having a √disyllabic stem · suffix or a √ monosyllabic stem · suffix · suffix shape. √go.zoù-ao/ 'water-LOC' is an illustration of the former, and √baì-dɯŋ-mɯn 'buy-PRF-PST' an instance of the latter. Rather, the rightmost element in these trisyllabic derived words get tonal association through tone spreading from the second syllable to the right edge. Thus the tonal phonology of Boro marks the initial two syllables of a trisyllabic word or the two syllables of a disyllabic word as a phonological unit and the right edge of this unit should be obligatorily associated with a lexical tone. It is also noticed from examples such as /dɯi-à/ 'water-NOM' that derived disyllabic words can surface with only one tone and thus the tone of the suffix is deleted and the tone of the stem shifts to the right edge. The domain of the Prosodic Word (henceforth PrWd) has been defined by many studies as the domain for interaction between word formation and various phonological processes like stress shift, vowel mutation, consonant devoicing etc. The PrWd is related to but not necessarily isomorphic to the morphological word (McCarthy & Prince 1993a; b; der Hulst 1999). Wheeldon and Lahiri (2002) describe the PrWd as the minimal unit of phonological encoding. The domain of the PrWd in Serbian is diagnosed by the presence of pitch accent prominence (Zec 2002) and it has been explained in terms of assigning primary stress in Greek (Nespor 1999). The motivation for PrWd as a phonological domain in SiSwati comes from long distance high tone shift. The rightmost high tone in SiSwati, as in other Nguni Bantu languages like Zulu, Xhosa and Ndebele generally surfaces on the antepenultimate syllable of the word (Hall & Kleinhenz 1999). Zsiga (1992) describes how the domain of a PrWd in Igbo is not coextensive with the syntactic word.

Earlier suggestions that the causative suffix /– hɯ̀/ has its own lexical specification (Sarmah 2004) and therefore forms its own PrWd domain are not followed in this paper. Notably the causative suffix /-hɯ̀/ can surface with its tone even when it occurs with a monosyllabic stem. The resultant derived disyllabic words after the addition of this suffix has both the tones of the stem and that of the suffix. Some examples are given in Table 1.

Under the condition where it is a disyllable, the tone spreads to the right edge. Suffixation leads to lexical tones of stems aligning to the TBU at the right edge. This happens irrespective of the suffix having its lexical specification or not. This tone on the right edge of a disyllable can be the tone of the underived monosyllable which shifts to the right edge or it can also be the tone of the affix (as in prefixes). This disyllabic condition is the maximal unit of tonal assignment or tonal shift. Tense and aspect suffixes present instances of such tonal migration. In Boro, tense and aspect is expressed by attaching six different suffixes to verbal roots. These suffixes are /-ɯ/ (PRSNT HAB), /-gɯn/ (FUT), /-gou/ (IMM FUT), /-bai/ (PRSNT PERF), /-dɯŋ/ (PRSNT PROG), /-dɯŋmɯn/ (PST). In this study, the pattern of occurrence of the tense-aspect suffixes with a few roots of high tone and a few others of low tone types was investigated. Trisyllables do not attest alignment but rather the nature of the shift seems to be more like spreading. This will be discussed in slightly more detail in section 2.1 in the context of tone spreading.

Among Boro affixes which are lexically specified for tone, only the prefixes belong to the dominant class as their addition changes the tonal specification of the stem. Although some suffixes are found to have lexically specified tones, their addition does not alter the tonal nature of the stems. Suffixes in Boro, irrespective of their lexical tonal status, belong to the recessive category. They may appear with their own tonal specification or they may bear the lexical tone of the stem. Prefixes in Boro, although they may have inherent tonal specification, do not form PrWds on their own. Prefixes become a part of a PrWd only after a sequence of stems. Lexical tones in such a PrWd has to fulfill the right alignment condition. This forces the tone of the prefix to move to the right edge of the PrWd domain.

Since Boro does not allow the occurrence of contour tones, this phenomenon of boundary alignment of the lexical tone within the PrWd domain results in (a) deletion of the lexical specification of the stem and (b) the tone of the prefix aligning with the right edge. This pattern of alignment is attested in both adjective and causative forming prefixes. This becomes evident in the process of derivation of /gɯ-gɯ̀/ 'pure' from the verb /gɯ́/ 'become pure'. The stem of this derived adjective is specified with high tone. But after

Table 1: The morpheme /hɯ̀/ persistently appears with its underlying tonal specification.

Word	Gloss
gó-hɯ̀	'escape'
gáb-hɯ̀	'cry'
zɯ́b-hɯ̀	'finish'
zám-hɯ̀	'old'
gí-hɯ̀	'fear'
búŋ-hɯ̀	'speak'
rúŋ-hɯ̀	'mild/soft'
gá-hɯ̀	'separate'
zí-hɯ̀	'to tear'
zò-hɯ̀	'sit'
súŋ-hɯ̀	'short'
rán-hɯ̀	'dry'
tʰàb-hɯ̀	'fasten'
hàm-hɯ̀	'become good'

prefixation, the specification of the stem changes to low. This can be explained by assuming that the prefix /gɯ̀-/ is underlyingly specified with low tone and it combines with the stem into the same PWrd. In such a situation the right alignment requirement makes the tone of the prefix to align with the right edge of the prosodic word. This results in changing the tonal specification of the stem /gɯ́/ 'become pure' to low. As the adjectival prefix in /gɯ-gɯ̀/ 'pure' becomes part of the same PrWd as the stem is, the lexical L of the prefix ultimately surfaces on the base, which is right aligned. This case presents an instance where the PrWd in Boro matches with the morphosyntactic word.

2.1 Tone shift versus tone spread

Boro suffixes without tonal specification do not form their own PrWd. Rather they get attached to the PrWd of the stem.

In such a situation they surface with the lexical tone of the stem. The pitch contours presented in Figure 1 for the Present Habitual (abbreviated as PRSNT-HAB) forms of verbs provide acoustic evidence for this. It is seen that in /tʰáŋ-ɯ/ 'go-PRSNT-HAB' the high tone on the suffix has shifted from the stem and in /lɯ̀ŋ-ɯ/ 'drink-PRSNT-HAB' the low tone has shifted to the suffix from the verb stem. Disyllabic stems followed by toneless suffixes present a slightly different picture. Instances of tone distribution within a disyllabic stem + suffix domain shows that the PrWd domain in Boro is mostly disyllabic. It is observed that the f_0 signal for the tone does not shift from the stem to the suffix, when a toneless suffix is added to a disyllabic stem, but it *spreads*. Figure 2 provides an instance of this.

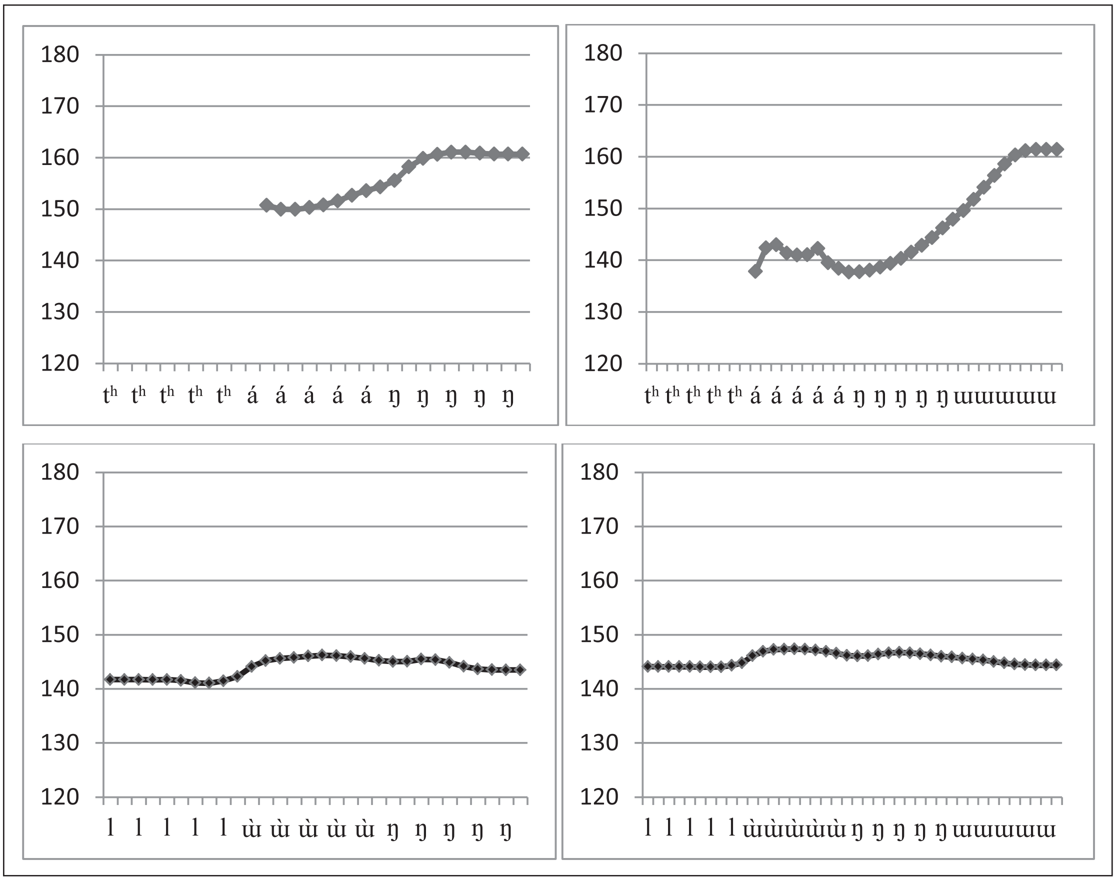

Figure 1: Tense-aspect suffix and tone shift. The upper panels show /tʰáŋ/ 'go' with and without the habitual present marking suffix /-ɯ/. The lower panels present the f_0 contour for /lɯ̀ŋ/ 'drink' with the same suffix. These are time normalized pitch contours for 25 iterations of each of the words (5 repetitions × 5 speakers).

Tone spreading to the third syllable is also noticed when the case marking suffix /-ao/ and the negative marking suffix /-akʰɯi/ are added to disyllabic stems. Figure 3 present the pitch contours of /gozoù-ao/ 'high-LOC' and /hatʰaí-ao/ 'house-LOC' where the locative case marker /-ao/ occurs as the third syllable.

Evidence from such disyllabic stems plus toneless suffixes in this investigation has revealed that the locus of tone alignment or where it will spread or shift will depend crucially on the number of syllables. This phenomena does not prominently surface in the case of low tone stems due to the low f_0 range of low tone and toneless syllables. But high tone spreading to a toneless suffix, following a disyllabic stem, has been observed for several stems and suffixes examined in this investigation. A list of such stems and their suffixed forms are presented in Table 2 below.

In the autosegmental literature, tone phenomena of spreading and shifting could be understood as locally bounded and their representation showed how shifting requires spreading followed by deletion of the tone in the original TBU (Kenstowicz & Kisseberth 1990). The spreading and shifting of Boro tones is represented in Figure 4.

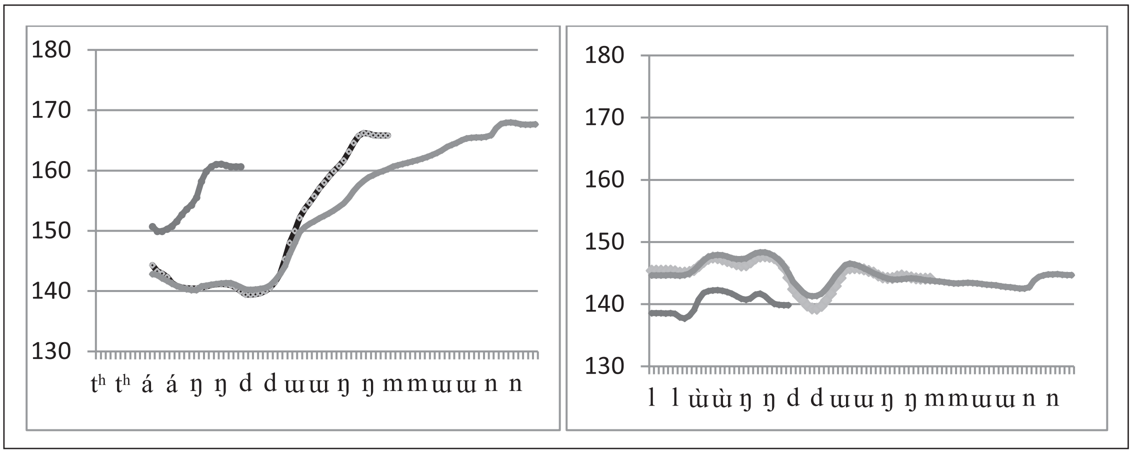

Figure 2: Tense aspect suffixes and tone spreading. Pitch contours of /tʰáŋ/ 'go' and /lɯ̀ŋ/ 'drink' with the suffixes /-dɯŋ/ and /-mɯn/ where the lexical tone spreads to the third syllable.

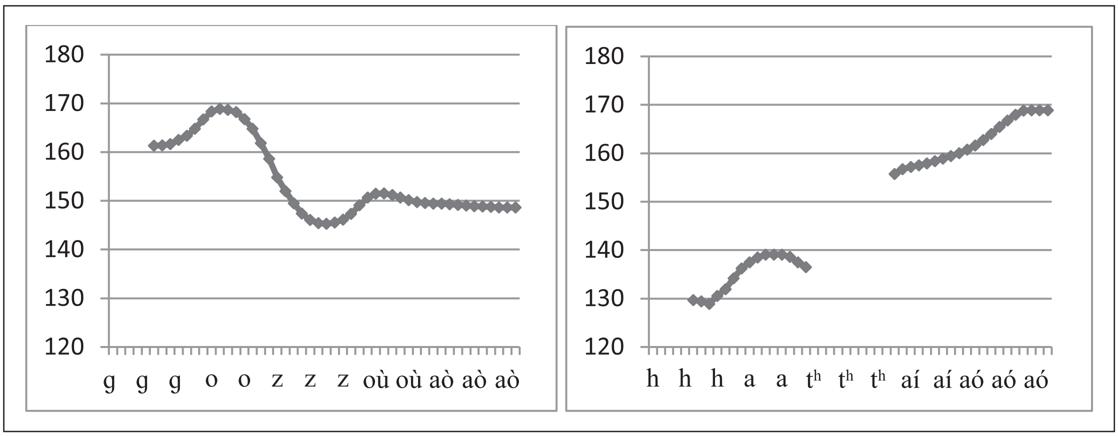

Figure 3: Locative inflection and tone spreading. Averaged time normalized pitch contour for the nouns /gozoù-ao/ 'water-LOC' and /hatʰaí-ao/[3] 'house-LOC' (n = 25).

[3] In Figures 3 and 4, tones are marked on the suffix for illustration of tone spreading. Everywhere else in the paper, tones are marked on suffixes only if they have underlying tone and not if they are a result of tone shift or spread.

Table 2: Tone spreading to the third syllable.

Stem	Suffixed Form
tʰaŋdɯ́ŋ 'go-PRSNT-PRF'	tʰaŋdɯ́ŋmɯ́n 'go-PST'
hatʰaí 'market'	hatʰaíjaó 'market-LOC'
adá 'elder brother'	adámɯ́n 'elder brother-Plural'
agɯí 'young sister'	agɯímɯ́n 'young sister-Plural'
abó 'elder sister'	abómɯ́n 'elder sister-Plural'
zajá 'eat-NEG'	zajákʰɯí 'eat-NEG-PST'
bibarí 'Bibari'	bibarínɯ́ 'Bibari-DAT'
nɯŋní 'you-GEN'	nɯŋníjaó 'you-POSS'

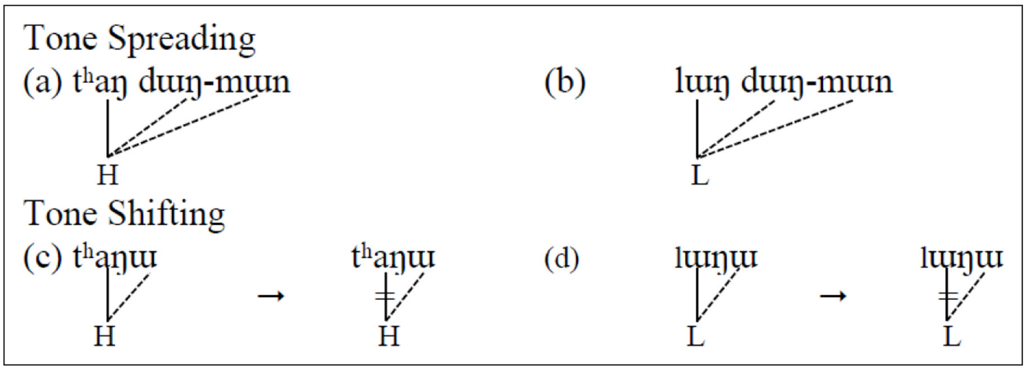

Figure 4: Tone spreading and shifting in Boro.

The correspondence between syllable length and prosodic word domain has been discussed in relation to other languages too. Zec (2002) observes that the prosodic word status in Serbian is diagnosed by pitch accent prominence, and disyllabic function words are matched with prosodic words, but those corresponding to a single syllable are not. Lehiste (2004) argues that in Serbo-Croatian, Swedish and Estonian, contrastive tones require a disyllabic domain to manifest. Examination of disyllabic stem plus toneless suffixes in Boro also suggests that the disyllabic stems, whether derived or non-derived, form a PrWd domain and the lexical tone is associated to the right edge of this domain.

Tone alignment in Boro in the context of word formation processes reveals the affixes which have their own tonal specifications. Some suffixes are found to have their lexical tones, but their addition does not alter the tonal nature of the stems. Inkelas & Zoll (2007), from Poser (1984) described that the dominant or recessive suffixes could be either high tones or low tones. Suffixes in Boro, irrespective of their lexical tonal status, belong to the recessive category. Prefixes belong exclusively to the dominant class as their addition changes the tonal specification of the stem. Although prefixes and suffixes in Boro are divergent in the way lexical tones are specified, neither of these always surface with their tonal specification. When suffixes become part of the disyllabic PrWd domain, they surface with the lexical specification of the stem. In such a situation they can surface with their lexical specifications. The examples below in Table 3 demonstrate this alignment in Boro.

Underlyingly non-tone bearing suffixes surface with the tone of the stems. When toneless suffixes form part of the PrWd, the lexical tone of the stem shifts to the right edge. Many languages define the domain of prosodic words according to their phonological properties. Although the lexical tones of both stems and suffixes can influence the principle of PrWd formation, these tones undergo further modification when they surface at the phrasal level.

Table 3: case marker suffixes and emphatic particles in Boro are always recessive.

Accusative case marker suffix: kʰoú			
dɯì	‘water’	dɯikʰoù	‘water ACC’
dìn	‘day’	dinkʰoù	‘day ACC’
àŋ	‘I’	aŋkʰoù	‘I ACC’
bedòr	‘meat’	bedòrkʰoú	‘meat ACC’
enzòr	‘rat’	enzòrkʰoú	‘rat ACC’
gotʰò	‘child’	gotʰòkʰoú	‘child ACC’
seŋrà	‘boy’	seŋràkʰoú	‘boy ACC’
Nominative case marker: á			
bàr	‘wind’	barà	‘wind NOM’
dɯì	‘water’	dɯià	‘water NOM’
dìn	‘day’	dinà	‘day NOM’
maozì	‘cat’	maozìá	‘cat NOM’
gotʰò	‘child’	gotʰòá	‘child NOM’
Genitive case marker: ní			
dɯì	‘water’	dɯinì	‘water GEN’
àŋ	‘I’	aŋnì	‘I GEN’
bɯrmà	‘goat’	bɯrmàní	‘goat GEN’
enzòr	‘rat’	enzòrní	‘rat GEN’
hazɯ̀	‘hill’	hazɯ̀ní	‘hill GEN’
Emphatic particles: bɯ́ and ló			
àŋ	‘I’	aŋbɯ̀	‘I also’
		aŋlò	‘I only’
mɯià	‘yesterday’	mɯiàbɯ́	‘yesterday also’
		mɯiàló	‘yesterday only’

3 Intonational phonology of Boro

In this paper we address the question whether it is possible to analyze the prosodic organization of a tone language based on its f_0 contour. Some of these issues have been discussed in Das & Mahanta (2016); Mahanta, Das & Gope (2016); Das (2017); Das & Mahanta (2018). This work presents additional results pertaining to scaling and alignment of tones at all levels of the prosodic hierarchy and therefore presents a consolidated account of Boro tone and intonation. The tradition of intonational phonology developed by Pierrehumbert (1980); Beckman & Pierrehumbert (1986); Pierrehumbert & Beckman (1988) is also followed in this study. Following the AM model of intonational phonology, this paper shows how initial boundary tone, downstepping, and phrasing, constitute the post-lexical component of a tone language like Boro. We will show that in the specific case of Boro, its prosodic organization is easily reflected in the phonological processes of downstep and downdrift. Additionally, the prevalence of boundary tones is also clearly reflected in the way tones uniformly rise and fall. The only aspect in which prosodic organization may be deficient is the near complete absence of pitch accents. The analysis presented here shows how downstep and declination in Boro create differences in tonal targets for the two lexical tones in the language. In addition to this, the paper also presents a detailed account of the way context determines the surface f_0 pattern of the right aligned lexical tones in PrWd domains.

It is shown that utterances in Boro can be grouped into prosodic units based on f_0 trends. Figure 5 presents the hierarchical relationship among these three levels of prosodic units.

The highest node in the hierarchy of the prosodic units in Boro is IP, which corresponds to a sentence. The next node below IP is that of the ip. An ip is motivated mainly by the intonational features of some of the sentences in Boro containing a subordinate clause, adjectival phrase, and/or a pre-posed object. The phonology of PrWd formation, which constitute the lowest level of prosodic unit, has been already discussed in the previous section.

Our analysis of Boro prosodic structure at the sentence level is based on three experiments. We reckoned that Boro required an instrumental analysis along with a proper understanding of the representational properties of its intonational constituents and categories. f0 is a continuous property and the tonal properties of Boro would also be encoded in the f0 signal. We studied the signal as well as the representational attributes of the signal to understand the hierarchical organization of prosodic categories in Boro.

3.1 Methodology, speech material and data collection

The study presented in this paper is based on data collected from 4 male speakers of Boro. The data set consisted of 140 scripted sentences which included neutral statements and statements expressing narrow focus by the process of ex-situ focus marking allowed in Boro. The sentences differed from each other in the sequence of lexical tones as well as in length. Each of the participants produced 7 renditions of all the sentences with sufficient amounts of pause in between. The first and the last iterations were not taken into account. In this way a total number of 2800 (140 sentence × 4 speakers × 5 recordings) recorded sentences constituted the data series for this experiment. The meaning of each of the sentences was repeated after each rendition of the sentences to remind the speakers of the kind of meaning they are supposed to produce.

The first set of data examines whether the phenomenon of downdrift/declination influences the pitch contours of utterances with a sequence of similar tones. A number of sentences in this set of data consisted of sequences of only high tones or low tones. A sequence of either three lexical tones or four lexical tones feature in these sentences. Within this group, 6 sentences consisted of only three lexical tones (3 each for low and high tones) aligned to the right edges of PrWds. The other 8 sentences within this group consisted of four lexical tones (4 each for low and hign tones) aligned to the right edges of PrWds. This experiment was crucial to understand downstep and downdrift patterns in Boro.

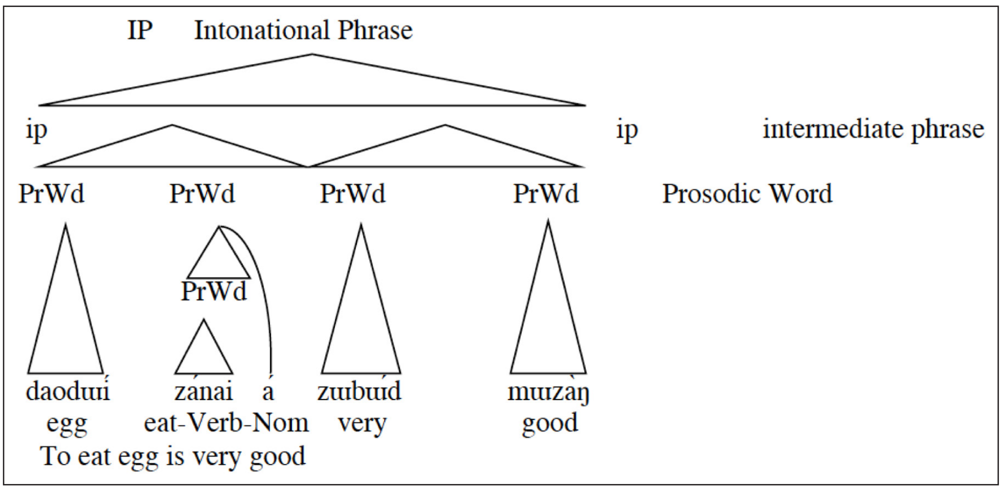

Figure 5: Boro intonational hierarchy.

The second set of data examines tone contrast in sentence initial, medial and final positions. The corpus for this data set included 40 sentences consisting of 20 pairs of related (near homophonous) constructions. These pairs of sentences differed from each other in only a high tone word occurring in place of a low tone word or vice versa. This is shown in (2). The substituted words with contrastive tones consisted of equal number of syllables and the rest of the text was also kept constant. In (2a) /daodɯí/ 'egg' is substituted by /bedòr/ 'meat' with the rest of the sentence remaining the same. In the other two examples, in (2b) /zá-k^{h}or/[4] 'gluttonous' is substituted by /lɯ̀ŋ-k^{h}or/ 'drukard' (sentence medial position) and in (2c) /t^{h}áŋ-gɯn/ 'go-FUT' is replaced by /p^{h}ɯì-gɯn/ 'come-FUT' (sentence final position). For each example, a phonetic notation is given followed by a morphological gloss and a translation.

(2) Tone contrast in sentence initial, medial and final positions

(a i) daodɯí baì-nai-á zɯbɯ́d mɯzàŋ
egg buy-Verb-NOM very good
'To buy eggs is very good.'

(a ii) bedòr baì-nai-á zɯbɯ́d mɯzàŋ.
meat buy-Verb-NOM very good
'To buy meat is very good.'

(b i) bí-ɯ zá-k^{h}or zàbai.
He-NOM gluttonous be-PRF
'He has become gluttonous.'

(b ii) bí-ɯ lɯ̀ŋ-k^{h}or zàbai.
he-NOM drunkard be-PRF
'He has become a drunkard.'

(c i) bí-ɯ t^{h}áŋ-gɯn.
He-NOM go-FUT
'He will go.'

(c ii) bí-ɯ p^{h}ɯì-gɯn.
he-NOM come-FUT
'He will come.'

The primary objective of this experiment was to examine whether the pitch contours of words change depending on their occurrence in phrase initial and medial positions. This experiment provided us with sufficient understanding of boundary patterns in Boro in different positions and repeated sentence patterns helped us to locate boundary tones in Boro. The final occurrence of the words were not examined since Boro follows Subject + Object + Verb word order and the final sentential slot is often occupied by the verb along with its inflections.

Only alternative questions[5] in Boro provide the context of the final occurrence of a non-verbal element. Thus the pitch contour of the initial occurrences of the words /daodɯí/ 'egg' in (3a) and /bedòr/ 'meat' in (3b) was compared with the medial and final occurrence of them in (3c) and (3d).

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[4] Tone marking in our examples consistently shows whether it is the stem or the suffix which bears the tonal specification. In cases of stems the tone is always marked on the right edge. Suffixes which are not specified for tone have no tonal marking.

[5] Alternative questions are a variety of yes/no questions and in Boro alternative questions are marked by the question particle 'na' occurring between the two alternatives presented to the addressee. Analysis of the pitch contours of these questions has revealed that alternative questions in Boro are marked with L%, with the question particle '-na' itself surfacing with a high f0 target.

(3) Tone and sentential contexts

(a) bikʰunzɯ́-á daodɯí baì-dɯŋ-mɯn.
mother-in-law-NOM egg buy-PRF-PST
'Mother-in-law bought eggs.'

(b) bikʰunzɯ́-á bedòr baì-dɯŋ-mɯn.
mother-in-law-NOM meat buy-PRF-PST
'Mother-in-law bought meat.'

(c) nɯ́ŋ má baì-gɯn, bedòr na daodɯí?
You what buy-FUT meat or egg?
'What will you buy?meat or egg?'

(d) nɯ́ŋ má baì-gɯn, daodɯi na bedòr ?
You what buy-FUT egg or meat?
'What will you buy? egg or meat?'

The third data set consisted of a series of 40 sentences with the same lexical items or sequence of lexical items occurring in sentence initial and medial positions. The objective of evaluating the pitch contours of such sentences was to examine how the same sequence of lexical tones in Boro surface depending on their sentential contexts. In the sentences in (4), the sequence of LH tones in Boro as seen in the word /gizì zí/ 'torn cloth', occur sentence initially and medially. Other combinations of lexical tones which belong to such pairs of sentences are HL (e.g. /nɯ́ŋ-nao zɯ̀o/ 'my rice beer'), LL (e.g. /àŋ-nao zɯ̀o/ 'my rice beer') and HH (e.g. /nɯ́ŋ-nao bɔ́n/ 'your firewood').

(4) Sequence of tones and sentential contexts

(a) gizi zí gàn-nɯ nàŋa.
torn cloth wear-PRSNT NEG
'Don't wear torn cloth.'

(b) bí-ɯ dinɯì gizì zí gàn-dɯŋ.
he-NOM today torn cloth wear-PRF
'He has worn torn cloth today.'

The fourth set of data included sentences with embedded clauses and longer phrases in subject or object positions. Constituents of such varying lengths were used to investigate the nature of phrasing allowed in Boro. This set of data consisted of 26 sentences. The last set of sentences in the data series are instances of sentence internal constituents preposed to sentence initial position. Boro allows this kind of construction for ex-situ focus marking. The sentences in (5) present some instances of this.

(5) Tone and ex-situ focus marking

(a) bí-ɯ daodɯí baì-dɯŋ-mɯn.
he-NOM egg buy-PST-PRF
'He bought egg.'

(b) daodɯí-kʰoú bí-ɯ baì-dɯŋ-mɯn.
egg-ACC he-NOM buy-PST-PRF
'It is eggs, he bought.'

(c) bí-ɯ bibarí-nɯ tʰaizoú hor-dɯ́ŋ.
he-NOM Bibari-DAT mango give-PRF
'He has given a mango to Bibari.'

(d) tʰaizoú-kʰoú bí-ɯ bibarí-nɯ hor-dɯ́ŋ.
mango-ACC he-NOM Bibari-DAT give-PRF
'It is a mango that he has given to Bibari.'

The experiments deliberately avoided conversational speech for a number of reasons. One primary reason was the near-impossibility of eliciting the exact test items type in spontaneous speech. The latter reason becomes clear when one takes into account the fact that sentences consisting of words with both lexical high and low tones cannot be built into the same conversation as these lexical items would mean different things. Conversational speech also needs to allow the participants enough time to produce the required intonational type which would rob the experiment of its naturalness. This experiment did not opt for this elicitation method owing to these practical yet unavoidable problems.

Four participants (male) participated as the subjects for this investigation. Each subject rehearsed the randomized list of scripted sentences in the presence of the experimenter. After the subject was familiarized with the sentences, she read them individually into a unidirectional headworn microphone connected with Edirol Roland R-09HR via xlr jack. The recordings were digitized at a sampling frequency of 44.1 kHz and 32 bit resolution. The subjects were allowed to re-record a sentence if they had apprehensions about the words or the intended meaning. The speakers produced the words embedded in the sentence frame. The speakers were between 22–28 years of age and they were born and raised in their native villages where the recording was conducted. All of them were from comparable socio-economic backgrounds. The experiment was carried out in a quiet environment at Bhatipara, Kazigaon and Bashbari villages. All the speakers were college educated and they had elementary knowledge of Assamese. None of the speakers had any previous record of hearing or listening impairment. Each speaker was paid a small fee for their participation in the production experiment. According to Basumatary (2005), the western Boro variety spoken in the districts of Kokrajhar, Dhubri and Chirang is recognized as the standard form of Boro language. From this viewpoint, the data collected for the present experiment can be described as the standard variety of Boro.

Each speaker produced 6 iterations of each word in the data set embedded in the sentence pattern mentioned above with sufficient pause in between. The subjects were asked to read aloud the sentences written in the Devnagari script. 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.

3.2 Data analysis and research questions

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 (Boersma and Weenink 2012). Individual sound files of the words were further segmented into the phoneme level and Praat TextGrid files were created for each word. Segmentation was based on spectrograms, zoomed waveforms, in addition to the aural verification of sound files. The segmented files were processed with a Praat Script [ProsodyPro] (Xu 2013) 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 meanf0, maxf0, minf0, duration and so on. The averaged normalized f0 values of all the iterations of each word (5 speaker × 5 iterations = 25) were plotted as line graph in order to observe the difference between the pitch contours of the words before and after affixation. Statistical tests were done in SPSS for evaluating whether the nature of difference in f_0 is statistically significant or not.

Most of the experimental blocks discussed above are not possible to be compared with one another as they constitute different sentential patterns. The data set are also controlled for their individual segments, tones and syntactic organization. These general questions are approached in this paper: 1) What role does local and global f0, and to a certain extent, intensity and duration play in the intonational organization of Boro? 2) How are tones affected in this intonational organization? 3) Do tones signal intonational organization in any way? 4) Are there intonation specific tones in Boro?

4 Basic intonation patterns in Boro

Boro lexical tones preserve their lexical specification at the IP level, except when the low tone occurs initially and the high tone when it occurs IP finally. This necessitates a look at the pitch contours of Boro words occurring at the left and right edges of IPs. This section discusses the way a sequence of lexical tones surface in Boro IPs. The experiments in this paper have looked at the intonation patterns of sentences with identical tones and also compared such sentences with sentences that have a sequence of mixed tones. It is found that the IPs in Boro surface with both downstepped tonal levels and with tonal targets undergoing declination. These experiments are described as experiments 2 and 3 in the materials section. The results are discussed in Section 4.2. The following section in 4.1 discusses tones in different positions in a sentence. Our analysis of intonation patterns in Boro are based on Das (2016) and presents a more consolidated analysis of the data in Das (2016).

4.1 Results: Sentential position and lexical tones

An important aspect of the way tones surface in tone languages is the way context influences their f_0 trend. This section describes the surface realizations of tones in Boro in IP initial, medial and final contexts. The results described here are from the second experiment described in the section on materials.

Tones produced in isolation can display pitch trends different from the way they are actually realized while occurring in the contexts of other tones. Figure 6 presents the time

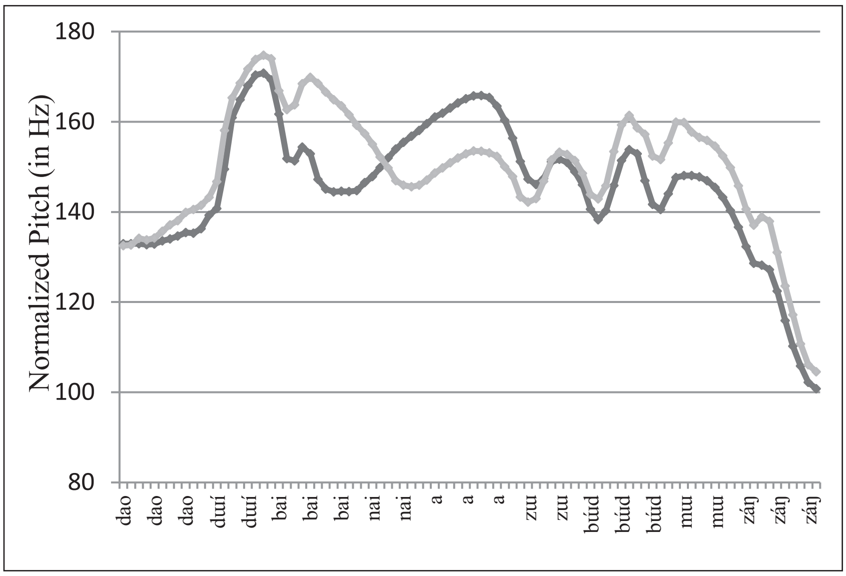

Figure 6: Tone contrast in IP medial position. Averaged Normalized Pitch contour of the homophonous sentences (n = 20) in (6) (a) and (6) (b).

normalized pitch contours aggregated for 20 tokens (4 speakers × 5 repetitions) for a homophonous and an ambiguous sentence. The only difference between the two sentences is the tone of the verb /baí/ 'break' as opposed to that of /baì/ 'buy'. In both the sentences the verbs are inflected with a verbal suffix /–nai/ and a nominal case marker /–á/. Generally, High tones in Boro surface with a rising contour and low tones with a falling contour or a low level contour. It can be seen in Figure 6 that /baí/ 'break' surfaces with a rising contour and the pitch continues to rise till the nominative marker /–á/. However, the pitch contour of the inflected form of /baì/ 'buy' shows a falling contour up to the verbal suffix /–nai/ which surfaces with the lexical tones of the stems in both the sentences.[6] Thus the nominative suffix /–á/ preserves its lexical specification even when it is preceded by a low tone aligned to /–nai/ in /baìnaiá/ 'buy-Verb-NOM'. The contrast between the pitch contours for /baí-nai-á/ 'breaking' as opposed to that of /baì-nai-á/ 'buying' shows that lexical tones in Boro preserve their lexical f_0 trend while occurring sentence medially. Contextual influence on lexical tone has been described in studies on Mandarin Chinese (Xu 1997), Thai (Potisuk et al. 1997) Yoruba (Laniran & Clements 2003) and Cantonese (Wong 2016).

(6) (a) daoduɯí baí-nai-á zɯbɯ́d mɯzàŋ (dark line).
egg break-NOM very good
'For eggs to break is very good.'

(b) daoduɯí baìnaiá zɯbɯ́d mɯzàŋ (light line).
egg buy-verb-NOM very good
'To buy eggs is very good.'

The left panel of Figure 7 shows that the pitch rise for the lexical H tone on the second syllable of /daoduɯí/ 'egg', is scaled lower when it is in the IP final position. The pitch contour surfaces with a comparatively retracted peak compared to the scaling of the f_0 peak for the other two occurrences of the word. The right panel of Figure 7 is quite important to understand the variances observed with respect to lexical low tone in IP initial position.

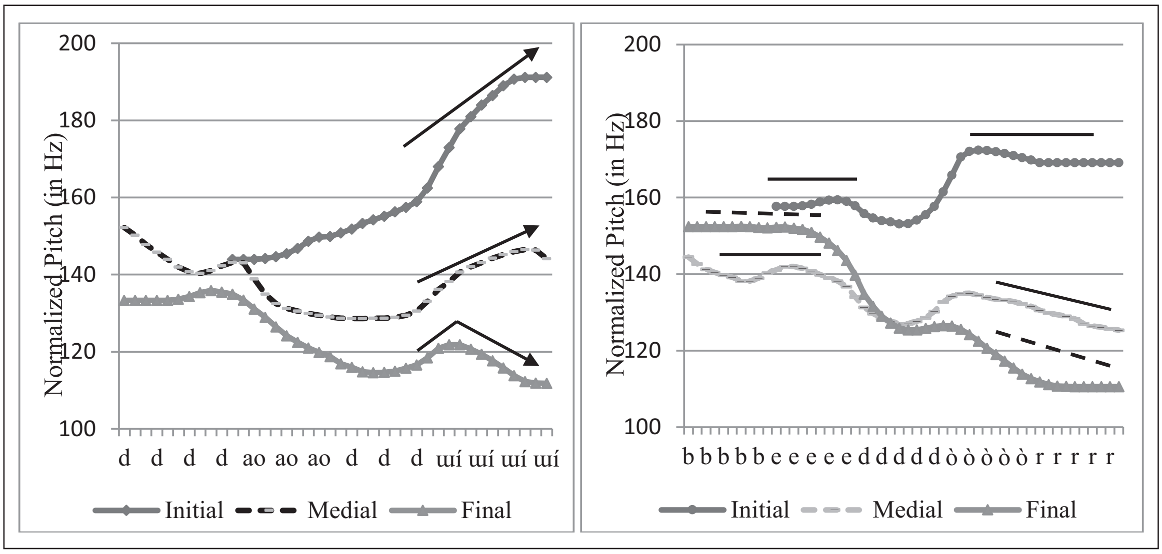

Figure 7: Lexical tones in IP initial, medial and final contexts. Averaged time normalized pitch contours of /daoduɯí/ 'egg' on the left panel and of /bedòr/ 'meat' on the right panel. The three contours in both the panels represents three IP contexts (n = 20).

[6] This is because /–nai/ is part of the minimum disyllabic PrWd domain.

The initial occurrence of /bedòr/ 'meat' is compared with its respective medial and final occurrences (as far as the shape of the pitch contour is concerned). The medial and final occurrences of /bedòr/ 'meat' surface with a falling pitch contour which is a characteristic pattern of Boro low tones in their citation forms. The initial occurrence of the word results in a raised pitch contour on the second syllable of /bedòr/ 'meat'. The mean f_0 of the vowel of first syllable (158.49 Hz, n = 20) is lower than that of the second syllable (171.22 Hz, n = 20) of the phrase initial occurrence of /bedòr/ 'meat'. This shows that the IP initial low tone surfaces with a low rise contour. Section 4.2 relates the scaling difference between the two syllables of the IP initial occurrence of /bedòr/ 'meat' to an intonational left edge boundary tone. Acoustic evidence presented in this section reveals the following intonational aspects of pitch contours of Boro sentences: (a) Tones preserve their lexical specifications only when they occur medially in IPs and (b) IP initial L tones surface with a rising f_0 trend.

4.2 Downstep within an ip

Boro IPs show that the language attests both processes of downstepping and declination of f_0 targets mentioned above. In sentences consisting of a sequence of high tones, each of the non-initial high targets is realized 30–40 Hz lower than the previous one. The pitch contour presented in Figure 7 provides evidence for two interesting prosodic facts of Boro. The first one is that the second high tone (H2) surfaces lower than the first one (H1). Mean f_0 of H1 (181.85 Hz) is higher than that of H2 (167.67 Hz). The third H tone (H3) surfaces lower (146.83 Hz) than that of H2. No low tone intervenes between the sequence of H tones in Figure 8 because in Boro polysyllabic words the lexical tones do not align to the first syllable. The rising pitch contours for all the three non-final high tones are quite obvious in Figure 8. Although both the ultimate and penultimate syllables in /daodɯí-á/ 'egg-NOM' surface with high tone, the second high tone surfaces higher than the first one. This shows that downstepping in Boro cannot affect tonal scaling within the PrWd domain.

Pitch tracks of sentences with an initial LH sequence are compared (in Figure 9 below) to that of initial HH sequences (the second tone bearing lexical unit remains constant). Figure 9 compares the time normalized pitch contours of two sentences where (1) /t^haizoú/ 'mango' occurs as the second constituent and it is preceded by /nɯ́ŋ-nao/ 'you-POSS' and (2) /t^haizoú/ 'mango' occurs as the second constituent and it is preceded by /àŋ-nao/ 'I-POSS' in the other. The averaged f_0 maximum (Maxf_0) (n = 20) of the second syllable of /t^haizoú/

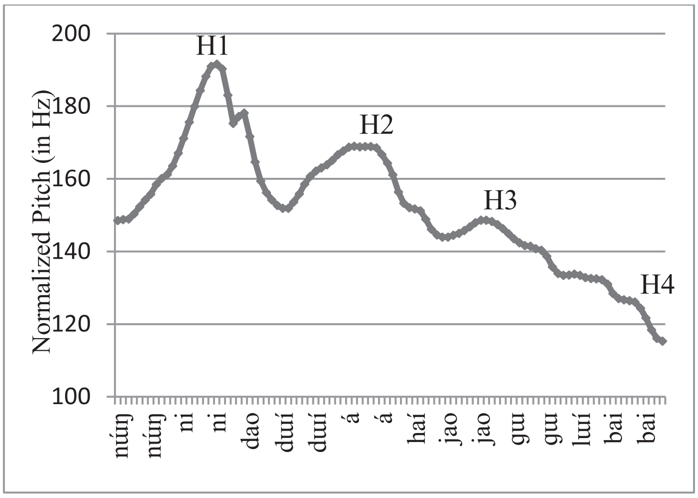

Figure 8: Downstepping of non-initial H tones. Time normalized pitch contour of an all H tone sentence /nɯ́ŋ-ni daodɯí-á haí-jao gɯlɯí-bai/ 'your egg has tumbled down'.

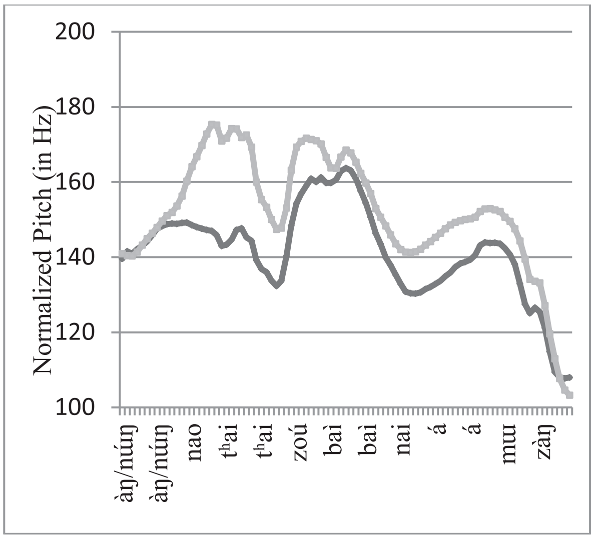

Figure 9: Downstepping of H followed by L. Averaged Normalized Pitch contour of the near-homophonous sentences (n = 20) (left panel) in (7) (a) and (7) (b).

'mango' is higher (163.21 Hz) when it is preceded by /nɯ́ŋ-nao/ 'you-POSS' as compared to the one following àŋ-nao 'I-POSS' (155.42 Hz). Two more Boro intonational facts can be inferred from Figure 9. In a sentence with an initial LHHL sequence of lexical tones, the first peak aligns to the first H tone which is followed by a downstepped H, before the pitch falls to the low boundary tone. Secondly the pitch register of the whole IP is lowered since it begins with an L tone. To understand this, the pitch contour for the HHHL sentence in the left panel of Figure 8 can be compared with that of the LHHL sentence in the same Figure.

(7) (a) nɯ́ŋ-nao tʰaizoú baì-nai-á mɯzàŋ (light).
You-LOC mango buy-NOM good
'It is good to buy mango at your place.'

(b) àŋ-nao tʰaizoú baì-nai-á mɯzàŋ (dark).
I-LOC mango buy-NOM good
'It is good to buy mango at my place.'

Boro H tones are scaled lower when they follow another high tone or a low tone. This is influenced by the post-lexical domain where downstepping is commonly attested at the ip level in Boro. All our evidence shows that terraced-tone type downstepping is an attribute of the intermediate phrase. This precise environment is a sequence of H tones in the ip domain and this downstepping never trespasses the ip boundary. It is possible to analyze this as a floating L tone in the ip domain but it's not clear what that postulation would mean for the phonology of Boro in general. Hence, we will rest our case in favour of an ip level downstepping domain in Boro.

4.3 Raising of L tones

The phenomenon of raising of L tone under the influence of H tones in the vicinity has been already attested in Thai (Pontisak et al. 1994) and Yoruba (Laniran & Clements 2003). In Akan, the medial L tone is raised by 10 Hz whereas the initial L in an LHLH sequence is not subject to any raising. (Genzel 2013). Visual examination of pitch tracks of Boro sentences with HL sequences has revealed that Boro L tones are raised when they are preceded by H tones. Figure 10 presents averaged time normalized pitch contours of two sentences differing in the tonal specification of the first element. The Mean f_0 of

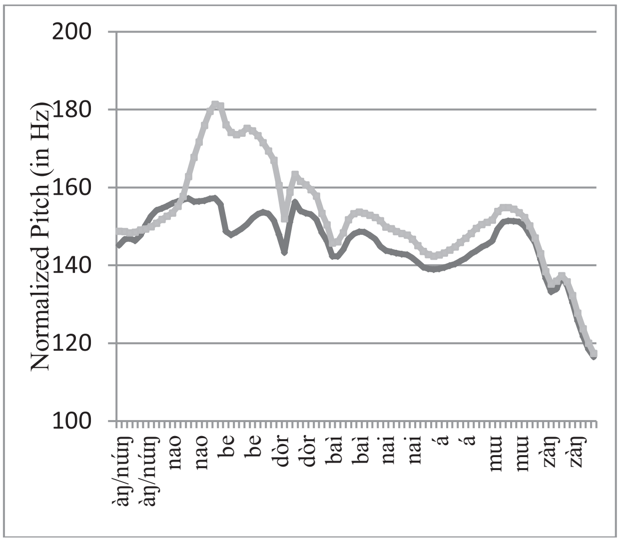

Figure 10: Averaged Normalized Pitch contour of the near-homophonous sentences in (8)(a) and (8)(b) (n = 20).

the second syllable of /bedòr/ 'meat' aggregated for all the speakers (n = 20) is found to be more (157.15 Hz) when the word is preceded by /nɯ́ŋ-nao/ 'you-LOC'. This can be compared to the aggregated Mean f_0 of the second syllable of /bedòr/ 'meat' (n = 20) (150.46) when the word is preceded by àŋ-nao 'I-LOC'. These results show that low tones in Boro are influenced by high tones and undergo raising when they are preceded by H tones. The pitch contours presented in Figure 10 also show how a sequence of LLHL sentence surface at the IP level in Boro. It can be seen that a late high tone in Boro may surface with a lower pitch than an early L. The late H in the LLHL sentence pattern is downstepped following the pattern of phonetic lowering discussed in section 4.2.

(8) (a) nɯ́ŋ-nao bedòr baì-nai-á mɯzàŋ (light).
You-LOC meat buy-NOM good
'It is good to buy meat at your place.'

(b) àŋ-nao bedòr baì-nai-á mɯzàŋ (dark).
I-LOC meat buy-NOM good
'It is good to buy meat at my place.'

4.4 Declination in an IP

It has been already shown in Figure 8 that all-H tone sentences in Boro result in downstepping of non-initial H tones. The all-L sentences in Boro do not show similar amount of pitch drop in the non-initial tones as is the case found to be in all-H utterances. Figure 11 presents averaged time normalized pitch contour of an all-L utterance. The gradual lowering of f_0 in the IP shows that pitch gradually drops to a lower level before it finally undergoes a steep fall. Figure 12 presents the downward f_0 trajectory of Maxf_0 for H tones of the all-H utterance. This is compared with the downward slope of Mean f_0 of L tones of the all-L utterance. It can be seen that for the all-H utterance, the f_0 falls from a higher peak to a lower f_0 target aligned to the final tone when compared to the f_0 slope of the all-L utterance. Table 4 compares the amount of f_0 drop for the non-initial tonal targets in both the all-H and all-L sentences. It can be seen that non-initial H tones in the all-H sentence undergo greater amount of pitch drop than non-initial L tones in the all-L sentence.

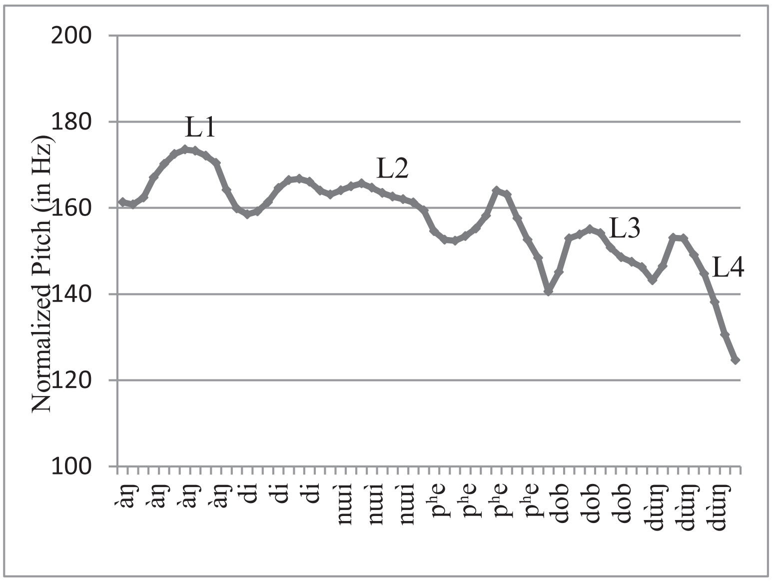

Figure 11: Pitch drop in IP with LLLL tone sequence. Averaged time normalized pitch contour of àŋ dinɯi̇̀ pʰedòb dɯ̀ŋ 'I have got slightly drunk today' (n = 20).

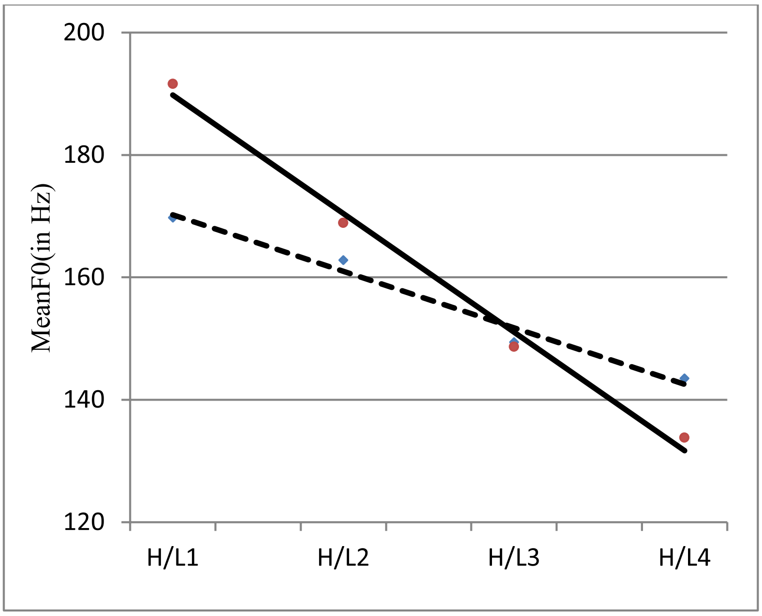

Figure 12: Comparison of pitch drop in IPs with HHHH and LLLL sequence. Pitch drop in the non-initial H tones in /nɯ́ŋ-ni daodɯí-á haí-jao gɯlɯí-bai/ 'your egg has tumbled down' and non-initial L tones in /àŋ dinɯì pʰedòb dɯ̀ŋ/ 'I have got slightly drunk today'. Mean of Max f_0 for each H tone (n = 20) and mean of Mean f_0 for each L tone (n = 20) are shown connected by a trend line.

Table 4: Pitch drop in HHHH and LLLL sequence.

	High	Pitch Drop	Low	Pitch Drop
1	191.63		169.79	
2	168.89	22.74 (hz)	162.82	6.97 (hz)
3	148.65	20.24 (hz)	149.41	13.41(hz)
4	133.81	14.84 (hz)	143.49	5.92 (hz)

The trend lines for downward pitch movement presented in Figure 11 also provide evidence for two kinds of downtrends in Boro insofar as pitch drop is concerned. Downstepping in Boro results in greater amount of f_0 lowering than the lowering attested in declination. Figure 11 presents an instance of final-lowering in Boro as the pitch contour drops to the lowest level towards the last part of the final syllable /dɯ̀ŋ/ ‘PRF’.

4.5 Boundary modification at the left edge

Initial occurrences of words with L tones in Boro are marked by a rise followed by a fall, although in citation forms L tones in Boro manifest phonetically by falling f_0 movement. Figure 10 presents the time normalized pitch contour of a sentence with /àŋ/ ‘I’ occurring in IP initial position. f_0 shapes of the L tone words vary when they occur in phrase initial position. An instance of it can be seen in the L tone word /àŋ/ ‘I’ which surfaces with an upward movement of the pitch followed by gradual drop of f_0 at the end of the coda consonant. This shows the robust nature of this initial contour in Boro as far as lexical low tone in the language is concerned.

Additionally, a comparison of the nature of distribution of these between initial and non-initial occurrences of L tones, and between initial occurrences of H and L tones in Boro is quite important for understanding the nature of f_0 movement for IP initial tones. Figure 13 presents pitch tracks of IPs with H and L tones occurring in the subject positions. It can be seen on the left panel of Figure 13 that the initial word /dɯì-ao/ ‘water-LOC’ surfaces with a rise aligned to the middle of the second syllable followed by a fall to a low target at the end of the suffix. The IP initial H tone also surfaces with a rising contour. The pitch contour in Figure 13 shows an IP with /bí-ɯ/ ‘he-NOM’ occurring initially in the right panel. In /bí-ɯ/ ‘he-NOM’ The High tone rises to a peak aligned to the second syllable. This rise in f_0 is characteristic of rising f_0 trends in Boro H tones. Thus the two panels of Figure 13 show that both the contrastive lexical tones occurring IP initially, surface with a rising pitch. The only noticeable difference is in the scaling of the targets. In the instance of /bí-ɯ/ ‘he-NOM’ the f_0 reaches a higher target. The high target for the f_0 rise of /dɯì-ao/ ‘water-LOC’ is scaled lower. This rise is consistently seen in all the other sentences in the dataset. It is also seen that the rise in f_0 affecting the initial L tone does not extend to the second L tone if there is one. The upper panel of Figure 14 shows the pitch track of an IP with a sequence of initial L tones in /ɡudùŋ dɯì/ ‘hot water’. It can be seen that the high target of the rising contour aligns to the surface TBU in /ɡudùŋ/ ‘hot’ and the second L tone aligned to /dɯì/ ‘water’ surfaces with the characteristic falling contour. Thus, where there’s an LL sequence of initial tones, the high target for the rising contour aligns to the first L tone. The f_0 trend

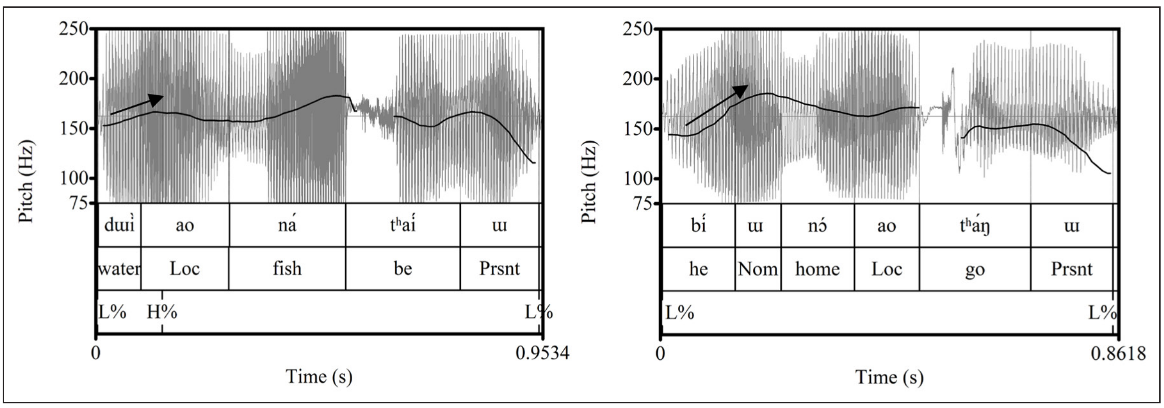

Figure 13: Comparison between IP initial occurrences for lexical L and H tones. Pitch track of /dɯì-ao ná tʰaíɯ/ ‘Fish lives in water’ in the left panel and of /bí-ɯ nɔ́-ao tʰáŋ-ɯ/ ‘he goes to home’ in the right panel.

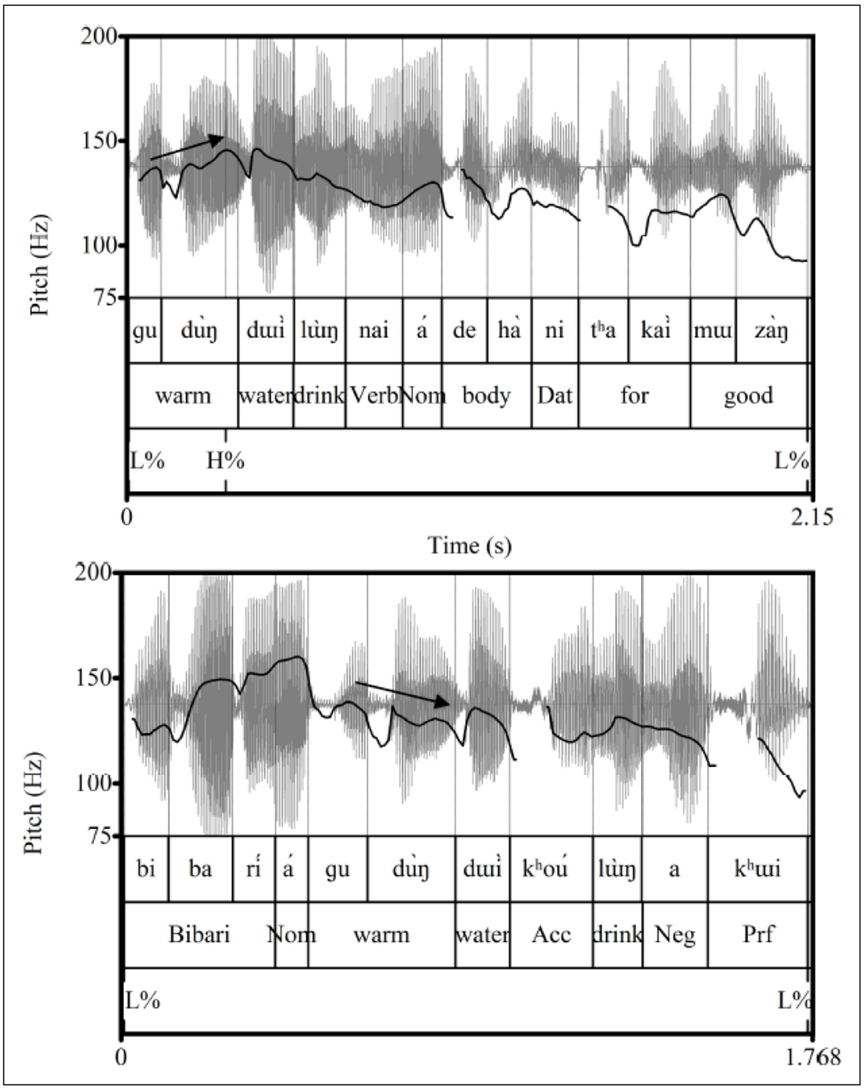

Figure 14: Comparison between IP initial and medial occurrences of LL tone sequence. Pitch track of /gudùŋ dɯì lùŋnaiá dehàní tʰakaì mɯzàŋ/ 'To have warm water is good for health' in the top left panel. The bottom panel presents the pitch track of /bibaríá gudùŋ dɯìkʰoú lùŋakʰɯi 'bibari/ does not drink warm water'. Both the pitch contours are produced by the same speaker.

of the initial sequence of LL tones in /gudùŋ dɯì/ 'hot water' can be compared with that of its medial occurrence presented in the lower panel of Figure 14. In the medial occurrence, the sequence of LL tones surface with a continuous fall as can be seen for /gudùŋdɯì/ 'hot water' in the lower panel of Figure 14. Despite the presence of the initial monosyllabic constituent (/àŋ/ 'I') or disyllabic (/gudùŋ/ 'hot') the L tone surfaces with a rising f_0 contour. In the case of a disyllabic constituent like /gudùŋ/ 'hot', the high target for the rising f_0 trend aligns to the second syllable. Despite their scaling differences, both H tones and L tones in Boro surface with a rising contour.

The left panel of Figure 15 presents the pitch contour of a sentence with a monosyllabic word with H tone occurring initially. In the right panel of Figure 15, a disyllabic word with H tone occurs initially. It can be seen that both the monosyllabic /nɯ́ŋ/ 'you' and the disyllabic /nɯ́ŋní/ 'you-POSS' surfaces with a rise in f_0. The peak of the f_0 rise aligns to the second syllable in /nɯ́ŋní/ 'you-POSS' and to the final segment of the first syllable in /nɯ́ŋ/ 'you'.

Another important aspect of IP initial pitch rise is highlighted by the left panel in Figure 16. It presents the pitch contour of an utterance with an initial LH sequence. The initial L tone aligned to the second syllable of /gizì/ 'torn' surfaces with a high target. The

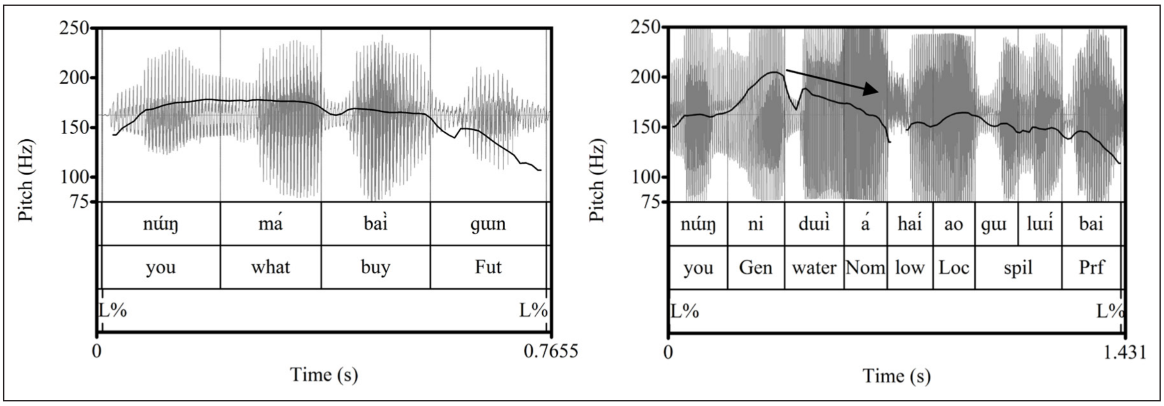

Figure 15: Pitch contour of IP initial H tone aligned to monosyllabic and disyllabic constituents. Pitch track of /nɯ́ŋ má baìgɯn/ 'What will you buy?' in the left panel and of /nɯ́ŋní dɯìá haíao gɯlɯ́ibai/ 'your water has spilled over' in the right panel produced by the same speaker.

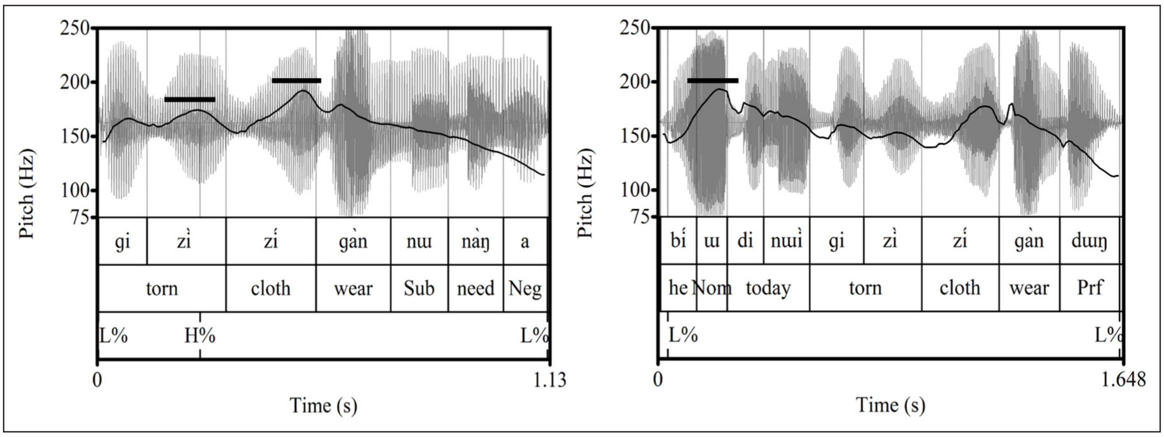

Figure 16: Comparison between IP initial and medial occurrences of LH tone sequence. Pitch track of /gizì zí gànnɯ nàŋa/ 'Don't wear torn cloth' in the left panel and /bí-ɯ dinɯì gizì zí gàndɯŋ/ 'He has worn torn cloth today' in the right panel produced by the same speaker.

pitch contours of the initial occurrence of /gizì/ 'torn' and that of its medial occurrence presented in the right panel of Figure 16 shows this comparison. But the high target for the f_0 rise of the IP initial L tone in /gizì/ 'torn' is scaled lower than the one found in the case of an IP initial H tone. The lines in Figure 16, and the rest of the discussion here, refer to f_0 heights aligned to a particular syllable. In other words, there exists a difference of scaling between the high target aligned to /gizì/ 'torn' and that of the lexical H tone aligned to the second syllable of bí-ɯ 'he-NOM'.

Higher *f0* target at the beginning of an utterance in non-tonal languages has been grammaticalized by proposing an H% initial boundary tone in English (Pierrehumbert 1980). Complex boundary tones consisting of a tone sequence can also occur at the left edge of prosodic units. The LHLH string marking accentual phrase is Seoul Korean is reduced to just an initial LH if the accentual phrase consists of three syllables (Jun 1993; 1998). Accentual phrases in Northern Bizkalan Basque are characterized by an initial pitch rise due to a sequence of LH tones where the target L occurs on the first syllable and the H aligns to the second syllable (Gussenhoven 2004). This is similar to what Pierrehumbert & Beckman (1988) proposes for Tokyo Japanese: the final L boundary tone of an accentual phrase surfaces on the next accentual phrase beginning with a H target. This results in an initial rise for the following accentual phrase and this rise is attributed to the sequence of LH initial boundary tone. In Northern Bizkalan Basque the realization of the LH initial boundary sequence depends on the availability of syllables.

The initial rising f_0 contour in Boro can also be interpreted as an initial LH% boundary tone. This left edge boundary tone interacts differently with the two contrastive tones in Boro. It influences the IP initial L tone in such a way that the tone surfaces with a rising contour. An instance of it is presented in the way /àŋ/ 'I' surfaces in Figure 20. The f_0 for the H% of the boundary LH% is scaled lower than that of the high target for an IP initial H tone. The comparison between the pitch contours for /dɯì-ao/ 'water-LOC' and /bí-ɯ/ 'he-NOM' in Figure 11 illustrates this aspect of intonation in Boro. The H% of the boundary LH% also does not cause downstepping of the following lexical H tone. The sequence of the boundary LH% and lexical H tones aligned to /gizì zí/ 'torn shirt' in Figure 16 shows it. It can be seen in Figure 16 that the L of the boundary LH% aligns to the first syllable of /gizì/ 'torn' and the H% surfaces aligned to the second syllable. Following this, the pitch is raised to an even higher target for the lexical H aligned to /zí/ 'shirt'. The alignment schema presented in 17 shows how LH% is squeezed when it is associated with a monosyllabic stem with L tone like /àŋ/ 'I'. When the boundary LH% associates with a disyllabic word with L tone, L aligns to the first syllable and H% aligns to the second syllable. LH% interacts with the initial H tone in such a way that the H% does not surface. This is irrespective of the number of syllables of the initial constituent. The alignment schema for /nɯ́ŋ/ 'you' and /nɯ́ŋní/ 'you-POSS', presented in Figure 16.

The LH% sequence does spread to a second L tone following the one occurring on the left edge of the IP. The pitch contour for /gudùŋ dɯì lɯ̀ŋnaiá dehàní tʰakaì mɯzàŋ/ 'To have warm water is good for health' in Figure 13 illustrates this. The H target for the LH% aligns to the second syllable of the word /gudùŋ/ 'warm' and the following word /dɯì/ 'water' surfaces with the characteristic falling f_0 trend for Boro L tones. Since the initial high tone preempts the occurrence of the H%, only L surface IP initially on a preceding H tone. Evaluation of the pitch contours in Figure 13 through Figure 16 shows that the high tone differs from the high target for initial LH% in terms of scaling.

5 Prosodic phrasing in Boro

One of the important aspects of the Autosegmental Metrical model of study of intonation is that of prosodic constituents to which intonational tones get associated. A related notion is propounded by prosodic phonology which analyzed speech into hierarchically organized prosodic constituents (Selkirk 1978; Nespor and Vogel 1986; Hayes 1989). Although intonational models of many non-tonal languages have segmented intonational contours into various levels of prosodic constituents, such kind of description of tonal languages is quite limited. Genzel (2013) and Kügler (2017) in their accounts of intonation in African tone languages find evidence for smaller prosodic chunks in the form of phonological phrases in Akan and Chimiini. The current description of Boro identifies two layers of prosodic structure marked by intonational tone. The unit occupying the highest level in this hierarchy is the IP and a smaller prosodic unit can be identified in the form of ip.

Ranked below the IP, the Intermediate phrase as an intonationally defined constituent was introduced by Beckman & Pierrehumbert (1986). The existence of an ip level of phrasing has been proposed for English (Beckman & Pierrehumbert 1986), Italian (D'Imperio 2002), Catalan (Feldhausen 2008) and also Cairene Arabic (Helmuth 2007). Prieto (2009) defines the intermediate phrase in Catalan in terms of the presence of a weaker disjuncture than that of IP. Khan (2008) describes the Bengali ip as a grouping of Accentual Phrases that form a tight syntactic unit, often corresponding to a small phrase and occasionally a clause.

5.1 The ip as a prosodic domain: Motivations

The ip in Boro is sometimes comprised of a clause or an adjectival phrase or in some other cases a pre-posed focus phrase. The evidence for the existence for the level of the intermediate phrase in Boro comes from the perspectives of (a) weaker disjuncture marking edges of non-final constituents larger than the PrWd and smaller than IP and (b) suspension of lowering of pitch targets for non-initial H tones. We find substantial instances of occurrences of both weak disjuncture and suspension of lowering of non-initial H tones in Boro.

If the argument for the existence of ip as a prosodic constituent stems from the realization of weaker disjunctures between two adjacent clauses, then the edges of ips in Boro proffer sufficient examples. The tones marking the edges of such ips in Boro do not show the same magnitude of pitch range modification as found in the case of IP right edge tones. IPs in Boro are characterized by a bigger inventory of right edge boundary marking tones than that is found in the case of ips.[7] Only non-final ips in Boro surface with their ip boundary tones. The boundary tones of the final ips get overridden by the final boundary tone of the IP. Figure 17 presents an instance of this.

The pitch contour of the sentence /bibríá mitʰigoɯ́di sɯ̀r daodɯí baìdɯŋmɯn/ 'Bibari knows who bought eggs' shows that the sentence consists of two ips forming an IP. The first ip, including the complementizer /di/ 'that', ends with an HL- ip boundary tone. Figure 18 shows how the pitch contour of the ip boundary tone exhibits a rise and a subsequent fall during the ip final syllable. The f_0 fall for HL- ip boundary tone is not realized in the same manner when the falling contour marks the edge of an IP. The right panel of Figure 18 presents the pitch contour of an IP with the boundary HL tone occurring in its right edge. A comparison between the pitch tracks shows that the HL boundary tone is realized differently depending on whether it aligns to the right edge of an ip or IP. The boundary tone of the second ip gets influenced by the L% IP boundary tone in the left panel of Figure 18 and the f_0 falls to a low target.

The second argument in favour of the ip level in Boro is based on the nature of pitch curves noticed in the case of some utterances. Section 4.2 has already presented evidence to show that in an IP consisting of H lexical tones, the non-initial ones undergo downstepping. The prosodic requirement of each of the final H tones within a series of non-initial PrWds undergoing pitch drop is violated in Boro IPs beginning with a nominative clause. The final tone of the nominative clause functioning as Subject NP does not affect the following H tone, and the latter surfaces with a higher pitch target than the earlier one. There are instances in the literature where suspension of downstepping has been interpreted

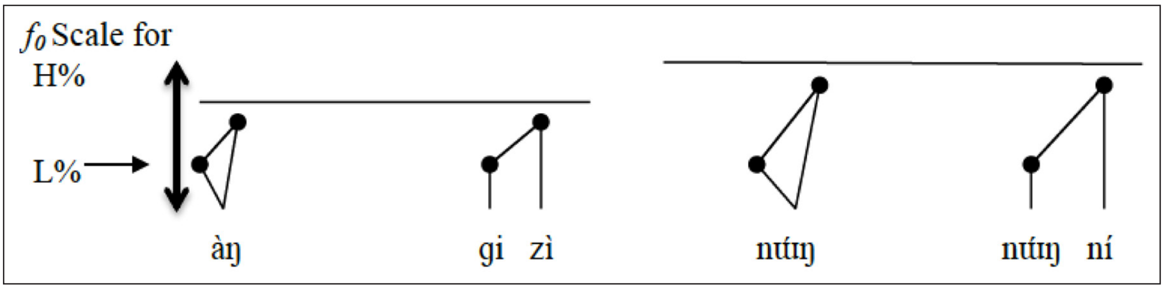

Figure 17: Alignment schema of initial LH% boundary tone.

[7] We have examined the pitch contours of various sentence types such as statements, wh-questions, yes/no questions etc and found that some sentence types in Boro are marked by monotonal boundary tone like L% or H% and some other sentence types end with bitonal boundary tones like LH% or HL%. The acoustic results of the interaction between the final lexical tones in IPs in Boro and the right edge boundary tones have shown that both the lexical specification and a monotonal intonational tone align to the rhyme of the IP final syllable. A scaling difference also surfaces for the f_0 target of the boundary tone depending on the two contrastive tones preceding it. Bitonal boundary tones may sometimes obliterate the f_0 specification of lexical tones. We have found that right edge boundary tones for IPs can have a global effect in addition to local impact in terms of alignment. It is shown that IP final intonational tone can also result in global raising of pitch contours in Boro. This is an extensive analysis of the right edge of prosodic boundaries of Boro and hence cannot be accounted for in this paper.

as evidence for marking a prosodic boundary in the study of intonation. Guessenhoven (2004), based on evidence from Poser (1984), Pierrehumbert and Beckman (1988) and Kubozono (1992), informs that in Tokyo Japanese the ip is the domain of downstep. The pitch contours presented in Figure 17 also show that downstepping is blocked after the nominative clauses due to a prosodic boundary.

In the left panel of Figure 19, the second H tone in the nominative clause /daodɯí zánaiá/ 'to eat egg' undergoes downstepping. But the third H tone aligned to the adjective /zɯbɯ́d/ 'very' surfaces higher than the preceding H tone. The mean of maximum f_0 (Maxf_0) of the final vowel in /zánai-á/ 'to eat' is 169.67 Hz (n = 20) compared to 175.10 Hz of that of the final vowel in /zɯbɯ́d/ 'very'. The ip boundary after the second H lexical tone blocks the downstepping of the third H lexical tone. The lengthened nominative clause in the right panel of Figure 19 also functions as a distinct prosodic unit. The nominative clause in the right panel of Figure 19 ends with a H lexical tone and the next lexical H tone is not downstepped. The mean of maximum f_0 (Maxf_0) of the final vowel in /zánai-á/ 'to eat' in the sentence /enzòrní bedòr zánaiá maozíní tʰakaì mɯzàŋ/ 'It is good for cat to eat rat meat' is 158.19 Hz (n = 20) compared to 168.81 Hz of that of the final vowel in /maozíní/ 'cat-POSS' in the same sentence. Figure 20 presents the comparison of Maxf_0 between two adjacent H lexical tones separated by ip boundaries. Based on

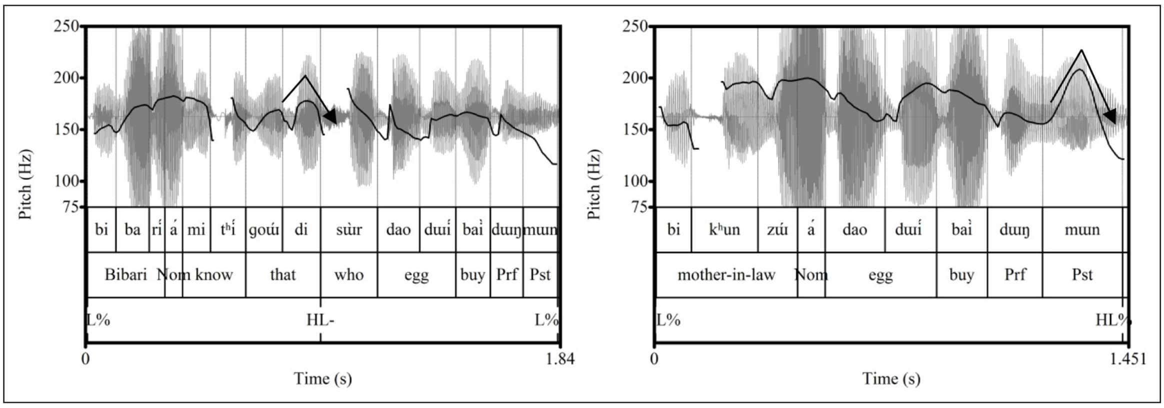

Figure 18: Right edge ip boundary tone for non-final ip. The first clause /bibríá mitʰigoɯ́di/ 'Bibari knows that.' surfaces with a falling boundary tone HL- in its right edge. This ip edge HL tone can be compared with the IP edge HL tone in the right panel presenting the pitch track of /bikʰunzɯ́á daodɯí baìdɯŋmɯn/? 'Mother-in-law bought egg?'

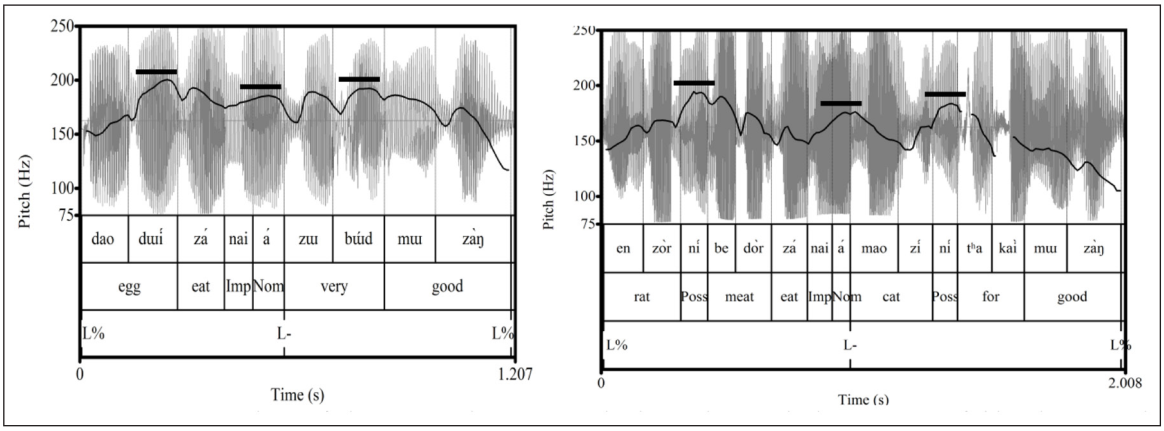

Figure 19: Suspension of downstepping across ip boundary. Pitch contour of /daodɯí zánai-á zɯbɯ́d mɯzàŋ/ 'It is good to eat egg' in the left panel and of /enzòrní bedòr zánaiá maozíní tʰakaì mɯzàŋ/ 'It is good for cat to eat rat meat' in the right panel.

the evidence presented above we surmise that suspension of downstepping in Boro is a prosodic cue for ips. Effectively, this results in the blocking of downstepping across ip boundaries.

Fronted and other topicalized constituents are often highlighted by intonational markers, such as pause or a boundary tone (Frascarelli 2000). Although the canonical word order in Boro is Subject + Object + Verb, it allows the object to be preposed to the initial position of a sentence for ex-situ focus marking. Noun phrases, which are thus placed sentence initially for ex-situ object focus (Kügler & Genzel 2013), also form ips in Boro. Figure 21 presents an instance of such kind of ex-situ focus marking where the object noun phrase /daodɯí/ 'egg' occurs sentence initially.

As can be seen in Figure 21, the right aligned H tone of the object is realized within the last syllable of the focused constituent and it is followed by an L ip boundary tone.

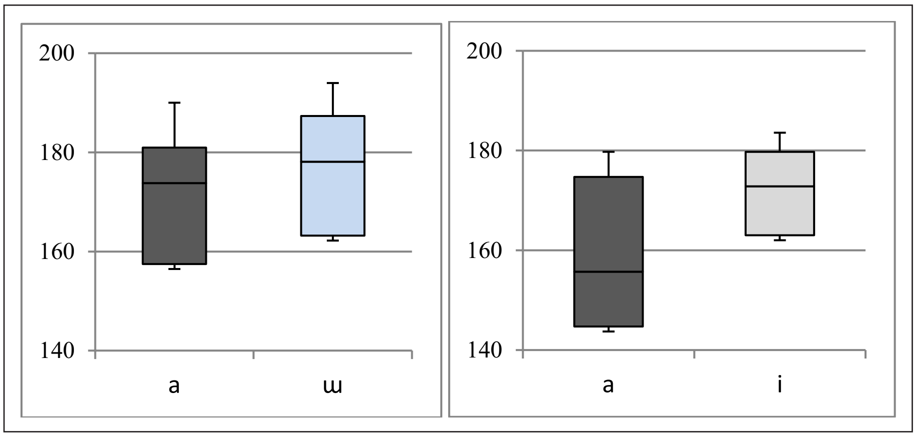

Figure 20: Maxf_0 for adjacent H tones across ip boundary. Comparison of maximum f_0 (Max f_0) between the final vowels in /zá-nai-á/ 'eat-verb-NOM' (left panel) and that of the final vowel in zɯbɯ́d 'very' in /daodɯí zánai-á zɯbɯ́d mɯzàŋ/ 'It is good to eat egg'. The right panel comapares the Maxf_0 of the final vowel in /zánai-á/ 'eat-Verb-NOM' and that of the final vowel in maozíní 'cat-POSS' in /enzòrní bedòr zánai-á maozíní tʰakaì mɯzàŋ/ 'It is good for cat to eat rat meat'.

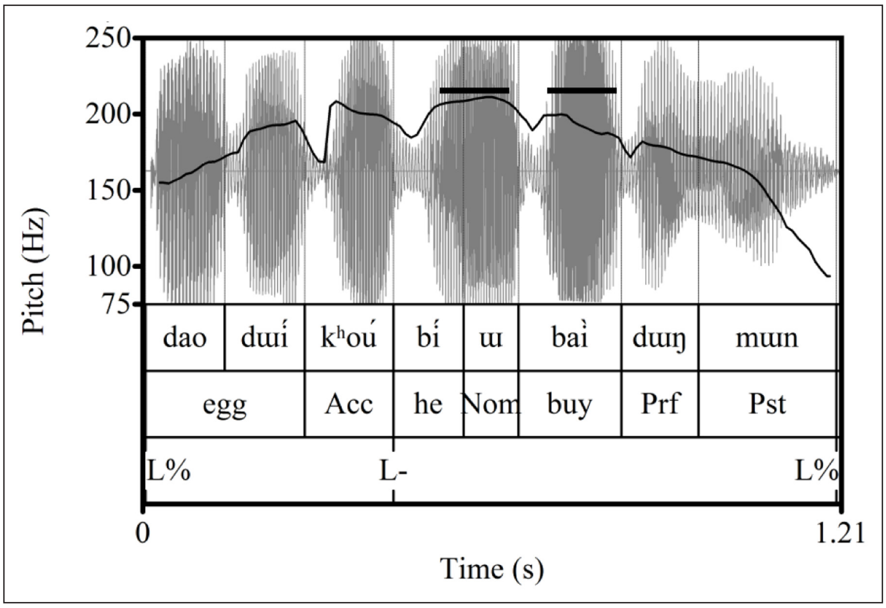

Figure 21: Preposed object with ex-situ focus followed by ip boundary. Pitch track of /daodɯíkʰoú bíɯ baìdɯŋmɯn/ 'EGG he bought' where the object NP /daodɯí/ 'egg' is pre-posed.

The evidence for the preposed object forming an ip can be attributed to the existence of downstepping in Boro. In Figure 21, with two lexical H tones in the first two words of /daoduí-kʰoú bí-ɯ baìdɯŋ-mɯn/ 'EGG he bought', the second H is realized with higher f_0 target than the first one. This evidence also suggests that downstepping is not applied across ips in Boro. As the pre-focused constituent /daodɯí-kʰoú/ 'egg-ACC' is followed by an ip boundary, the following H tone in bíɯ 'he-NOM' is not downstepped. This suggest that ip is the domain of downstepping in Boro. Figure 22 presents another instance of an IP with a preposed object receiving ex-situ focus.

The pitch contour presented in Figure 22 is of a sentence consisting of a direct and an indirect object with a di-transitive verb. This Figure shows that the second H tone surfaces with a higher f_0 target than the first one, thus negating any pitch drop for downstepping. The initial PrWd /tʰaizoú-kʰoú/ 'mango-ACC' is followed by an ip boundary. The second ip in Figure 22 follows the characteristic downstepping of non-initial H tones. The H tone in /bibarí-nɯ/ 'Bibari-DAT' surfaces lower than the ip initial H tone in /bí-ɯ/ 'he-NOM'. Downstepping of non-initial H tones within an ip domain can also be seen in preposed constituents with additional H lexical tones. Figure 23 presents the pitch contour of a longer IP.

In Figure 23, constituents in the pre-posed object /tʰaisé tʰaizoú/ 'one mango' have lexical H tones and the second H tone undergoes a pitch level drop. The pitch again rises to a high target for the third H followed by a downstepped H tone. The ip prosodic boundary after the preposed object /tʰaisé tʰaizoú/ 'one mango' prohibits the percolation of downstepping to the next H tone in /bibarí-ní/ 'Bibari POSS'. However the second H tone in the second ip in Figure 23 undergoes downstepping. The H tone in /pʰisazɯ́-á/ 'daughter-NOM' appears lower than that of /bibarí-ní/ 'Bibari POSS. This shows that the domain of downstepping can be a prosodically determined domain and crucial for the operation of sentence level prosody in Boro.

6 Intonational Phrase (IP)

The largest tonally-marked unit in Boro prosody can be described as the IP. The IP is marked by a major continuation rise or a major final fall (Jun & Fougeron 2000). Pierrehumbert (1980) presents evidence to suggest that the right edge of the IP is marked by a H% or L% which is realized on the last syllable of the IP. This level is also marked by significant

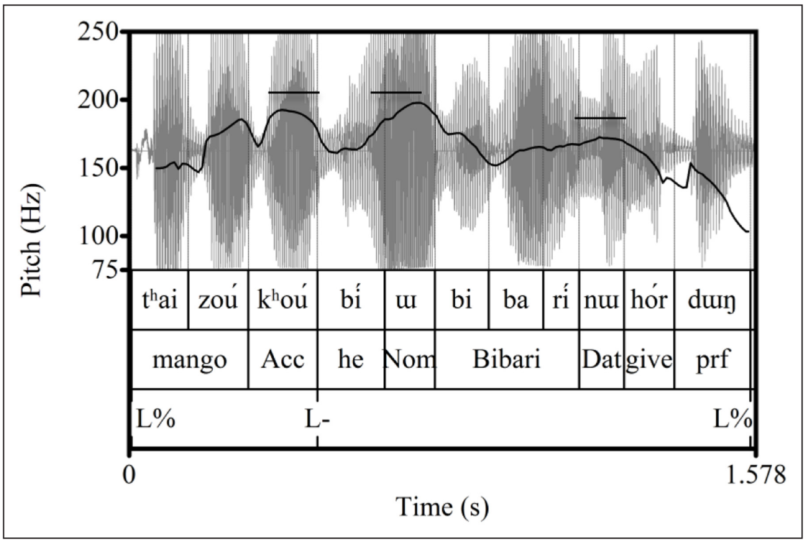

Figure 22: ip boundary after preposed object with ex-situ focus and suspension of downstepping across ip boundary. Pitch track of /tʰaizoú-kʰoú bí-ɯ bibarí-nɯ hór-dɯŋ/ 'He gave a mango to Bibari' where the direct object /tʰaizoú/ 'mango' is pre-posed to the IP initial position.

final lengthening and is optionally followed by a pause (Jun & Fougeron 2000). In general, major phrase boundaries tend to be associated with longer pauses, greater and more complex tonal changes, and more final lengthening than minor boundaries (Prieto 2009). The IP in Boro also exhibit some of these features. This section presents acoustic evidence to suggest that IPs in Boro are marked by major rise or final fall, and also by pause in the presence of two IPs which constitute the highest level of prosodic hierarchy, which is described as Utterance in Selkirk (2009). The IP is the prosodic domain within which pitch range is specified, and thus at the start of each new IP, the speaker chooses a new range which is independent of the former specification. Figure 24 shows how a simple sentence like /aŋ̀ pʰɯ̀i-gɯn/ 'I will come' with the subject NP and VP forms an IP ending in a final fall.

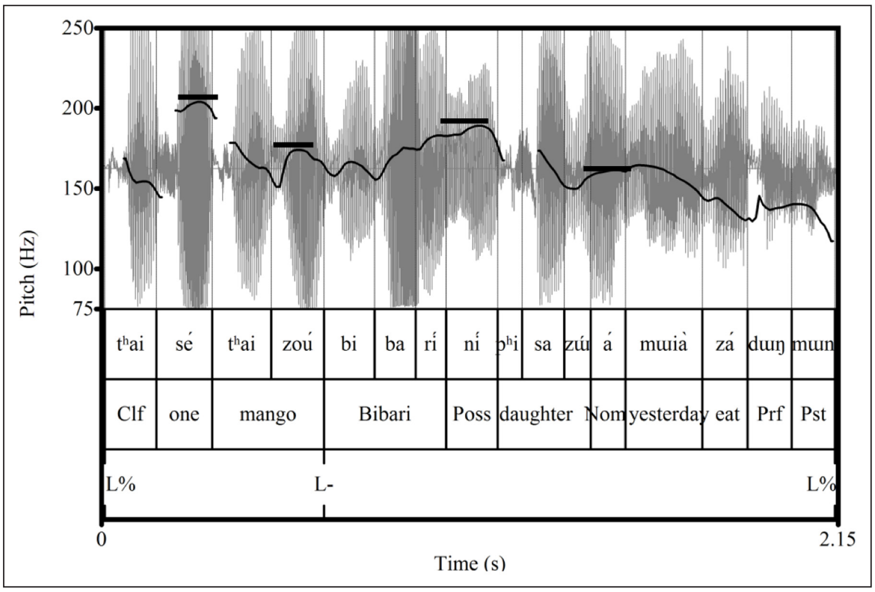

Figure 23: ip boundary L- blocks downstepping of the following H tone. Pitch track of /tʰaisé tʰaizoú bibarí-ní pʰisazɯ́-á mɯi-à zá-dɯŋ-mɯn/ 'Bibari's daughter ate one mango yesterday' with the object tʰaisé tʰaizoú 'one mango' receiving ex-situ focus.

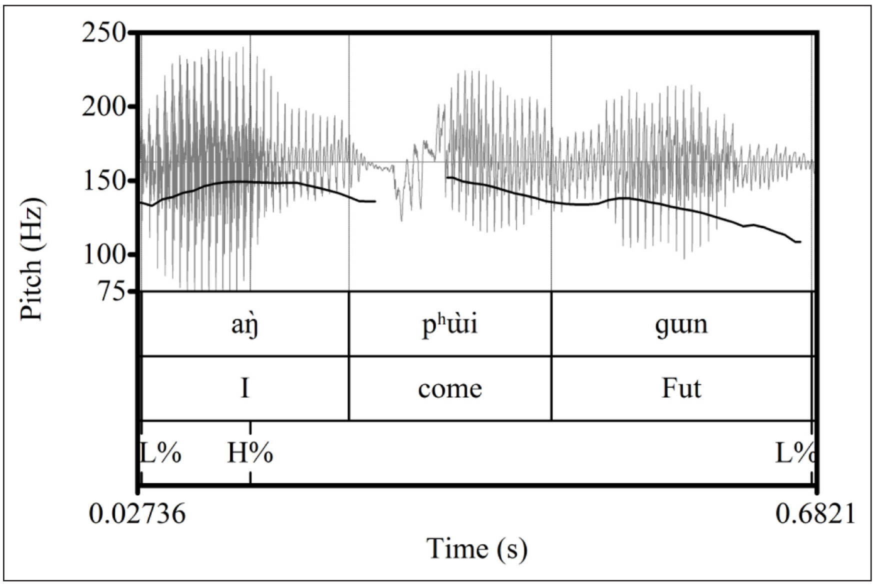

Figure 24: Final fall and IP boundary. Pitch contour for the IP /aŋ̀ pʰɯ̀i-gɯn/ 'I will come' ending in f_0 minimum.

The edge here is marked by the extreme drop in the f_0 in the final syllable. The edge of IPs can also be demarcated by a pause. Unlike Figures 24 and 25 presents the contour of an utterance with two IPs. The edge of the first IP is not only marked by the major rise in the f_0 contour, it is also suggested by the amount of pause before the second IP starts.

Average duration (n = 20) of the last syllable of the sentence, i.e. /-mɯn/ in Figure 26, is found to be higher (189.58 msec) than the preceding two syllables. The average duration for /baì/ is found to be 157.53 msec. and for /-dɯŋ/ it is 146.15 msec. (n = 20). Thus lengthening of the final syllable provides further phonetic cue for determining IP boundaries in Boro.

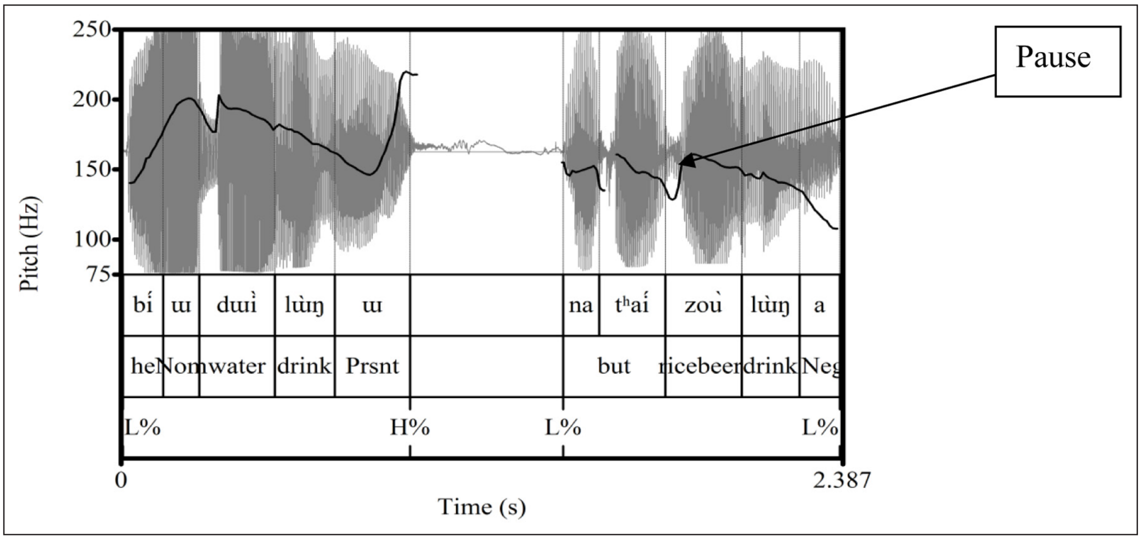

Figure 25: Pause and major pitch movement, and IP boundary. Pitch contour of the utterance /bíɯ dɯì lɯ̀ŋ-ɯ natʰai zoù lɯ̀ŋ-a/ 'He drinks water but does not drink rice beer'. The pause before /natʰai/ 'but' separates the two IPs in the utterance. Another evidence that supports the IP as a prosodic unit is the lengthening of the final syllable of the phrase. Figure 26 presents the pitch contour for the sentence /bikʰunzɯ́a daodɯí baì-dɯŋ-mɯn/ 'Mother-in-law bought eggs.

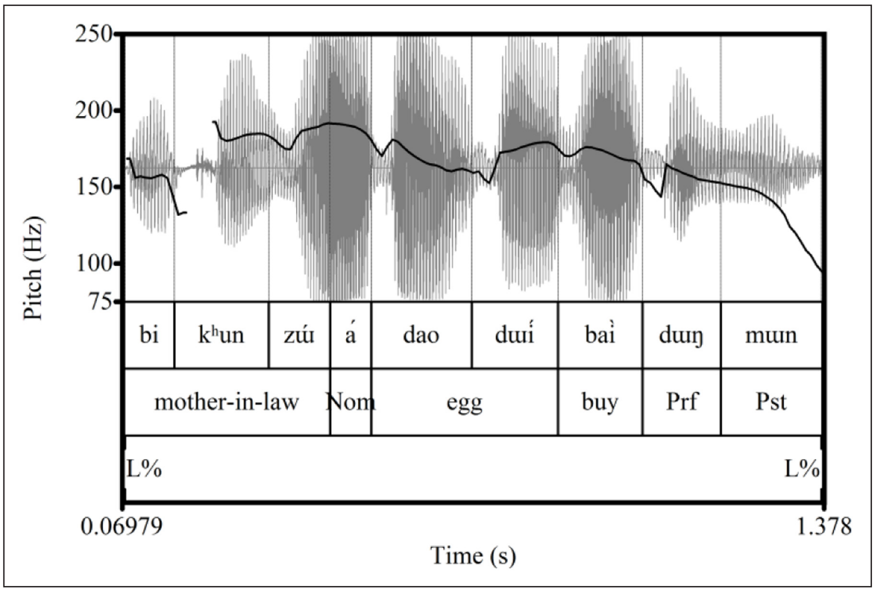

Figure 26: Final lengthening and IP boundary. The final syllable of the IPs have been found to be longer than the preceding ones as is the case for /-mɯn/ in the sentence /bikʰunzɯ́á daodɯí baìdɯŋmɯn/ 'Mother-in-law bought eggs'.

7 Conclusion

Although studies on intonation systems of the languages of the world have been growing over the years, the interaction between intonation and lexical tone is yet to be extensively pursued. Most studies on the properties of intonational interference in tone languages have taken into account two aspects. Detailed accounts of the way information structure controls the surface realizations of lexical tones are presented in Jannedy (2007); Karlsson, Svantesson & House (2012); Kügler & Genzel (2012); Kügler & Skopeteas (2006) and Xu (1999). Other studies like Gussenhoven & Vliet (1999); Inkelas & Leben (1991); Lee (2004), Ma et al. (2006); Myers (1996) and Rialland (2007) have discussed how boundary intonational tones affect the lexical tones in utterances. Recent studies on Yoruba (Fajobi 2005), Akan (Genzel 2013; Kügler 2017), Bemba (Kula & Hamann 2017), Chichewa and Tumbuka (Downing 2017) have revealed more about the nature of intonational interference in tone languages. We have shown in this paper how a two tone language like Boro permits intonational modification of lexical tones at the IP level.

In Boro, the initial IP boundary tone is always rising, irrespective of High or Low tone but relative height is less for a Low tone and higher for a High tone. Non-terminal High IP tones are always higher than terminal ones but where the initial IP boundary is concerned the lexically specified High or Low tones have different relative heights. In sum, we found three levels of prosodic constituents in Boro: PrWd, ip and IP. PrWd is the domain for distribution of lexical tones. The ip in Boro functions as the domain of downstepping of H lexical tones. The highest level of prosodic constituency is the IP which is marked by both initial and final boundary tones. The hierarchical tree for prosodic constituents in Boro presented in Figure 2 captures this dimension of Boro intonational phonology. Edges are demarcated such that the left edge has a LH% boundary tone which interacts differently with the two lexical tones. Both the targets for LH% surface when an L tone occurs in IP initial position. In the presence of an IP initial H tone, only the L target for LH% precedes the high target for the lexical H tone. Lexical tones preserve their characteristic pitch trend when they occur medially in IPs. IP initial L tones and IP final H tones bear the mark of intonational modifications in their surface realizations. Downstepping results in a sequence of terraced H tones and declination results in gradual fall in tonal targets for a sequence of L tones.

Boro presents a fresh perspective insofar as the way intonation is allowed to play its role in tone languages. In response to the research questions posed in Section 3.1 of this paper we can surmise that both local and global f0 play a role in intonational organization in Boro. Tones are influenced to quite an extent to signal intonation and intonation specific tones are to be found at the phrasal boundaries and they are also constrained by lexical tones.

Abbreviations

ACC = Accusative, DAT = Dative, FUT = Future, GEN = Genitive, HAB = Habitual, IMM = Immediate, LOC = Locative, NEG = Negative, NOM = Nominative, PST = Past, POSS = Possessive, PRF = Perfect, PRSNT = Present

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Competing Interests

The authors have no competing interests to declare.

References

Basumatary, Phukan. 2005. *An introduction to the Boro language*. New Delhi: Mittal Publications.

Beckman, Mary & Janet Pierrehumbert. 1986. Intonational structure in English and Japanese. *Phonology Yearbook* 3(1). 255–310. DOI: https://doi.org/10.1017/S095267570000066X

Bhat, Shankara. 1968. *Boro vocabulary with a grammatical sketch*. Pune: Deccan College Post-graduate and Research Institute.

Bhattacharya, Pramod. 1977. *A descriptive analysis of the Boro language*. Guwahati: Gauhati University Department of Publication.

Boersma, Paul & David Weenik. 2012. Praat: doing phonetics by computer (Version 5.3.04_win32) [Computer programme]. http://www.praat.org/Bradley 1982.

Boro, Madhuram. 2007. *The historical development of Boro language*. Guwahati: NL Publications

Burling, Robbins. 1959. Proto-Bodo. *Language* 35(3). 433–453. DOI: https://doi.org/10.2307/411231

Burton-Page, John. 1955. An analysis of the syllable in Boro. *Indian Linguistics* 16. 334–344.

Das, Kalyan. 2017. *Tone and Intonation in Boro*. Guwahati: IIT Guwahati dissertation.

Das, Kalyan & Shakuntala Mahanta. 2016. Tonal alignment and prosodic word domains in Boro. *Proceedings of Tonal Aspects of Languages* 15. 111–115. DOI: https://doi.org/10.21437/TAL.2016-24

Das, Kalyan & Shakuntala Mahanta. 2018. Distribution of lexical tones in Boro. *Himalayan Linguistics* 17(2). 52–76. DOI: https://doi.org/10.5070/H917238628

DeLancey, Scott. 2010. Language replacement and the spread of Tibeto-Burman. *Journal of the Southeast Asian Linguistics Society* 3(1). 40–55. http://www.jseals.org/JSEALS-3-1.pdf.

DeLancey, Scott. 2011. "Optional" "Ergativity" in Tibeto-Burman Languages. *Linguistics of the Tibeto-Burman Area* 34(2). 21–47.

D'Imperio, Mariapaola. 2002. Italian intonation: An overview and some questions. *Probus* 14(1). 37–69. DOI: https://doi.org/10.1515/prbs.2002.005

Downing, Laura. 2017. Tone and Intonation in Chichewa and Tumbuka. In Laura Downing and Annie Rialland (eds.), *Intonation in African tone languages*, 365–392. DOI: https://doi.org/10.1515/9783110503524-011

Fajobi, Eunice. 2005. The nature of Yoruba intonation: a new experimental study. In Toyin Falola and Ann Genova (eds.), *Yoruba Creativity: fiction, language, life and songs*, 183–221. New Jersey: Africa World Press Inc.

Feldhausen, Ingo. 2008. *The prosody-syntax interface in Catalan*. Potsdam: University of Postdam dissertation.

Frascarelli, Mara. 2000. The syntax-phonology interface in focus and topic constructions in Italian. *Springer Science & Business Media* 50. 193–209. DOI: https://doi.org/10.1007/978-94-015-9500-1_4

Gårding, Eva. 1979. Sentence intonation in Swedish. *Phonetica* 36(3). 207–215. DOI: https://doi.org/10.1159/000259959

Genzel, Suzanne. 2013. *Lexical and post-lexical tones in Akan*. Potsdam: Universität Potsdam dissertation.

Grierson, George. 1903. *Linguistic Survey of India*. Calcutta: Government Press.

Gussenhoven, Carlos. 2000. On the origin and development of the Central Franconian tone. *Analogy, Levelling, Markedness: Principles of change in phonology and morphology*, 213–260.

Gussenhoven, Carlos. 2002. Intonation and interpretation: phonetics and phonology. *Speech Prosody 2002 International Conference*, 47–57.
Gussenhoven, Carlos. 2004. *The phonology of tone and intonation*. Cambridge: Cambridge University Press. DOI: https://doi.org/10.1017/CBO9780511616983
Gussenhoven, Carlos. 2012. Tone and intonation in Cantonese English. *Proceedings of the Third International Symposium on Tonal Aspects of Languages*, 1–4.
Gussenhoven, Carlos & Peter Van der Vliet. 1999. The phonology of tone and intonation in the Dutch dialect of Venlo. *Journal of Linguistics* 35(1). 99–135. DOI: https://doi.org/10.1017/S0022226798007324
Hall, Tracy Alan and Ursula Kleinhenz, (eds.). 1999. *Studies on the phonological word*, 174. John Benjamins. DOI: https://doi.org/10.1075/cilt.174
Hayes, Bruce. 1989. The Prosodic Hierarchy in meter. In Paul Kiparsky & Gilbert Youmans (eds.), *Rhythm and Meter*, 201–260. Orlando, FL: Academic Press. DOI: https://doi.org/10.1016/B978-0-12-409340-9.50013-9
Hellmuth, Sam. 2007. The relationship between prosodic structure and pitch accent distribution: evidence from Egyptian Arabic. *The Linguistic Review* 24. 291–316. DOI: https://doi.org/10.1515/TLR.2007.011
Ho, Aichen. 1977. Intonation variation in a Mandarin sentence for three expressions: interrogative, exclamatory and declarative. *Phonetica* 34(6). 446–457. DOI: https://doi.org/10.1159/000259916
Hodgson, Brian. 1847. *On the Kocch, Bódo and Dhimál tribes*. Calcutta: Baptist Mission Press.
Hyman, Larry. 1990. Boundary tonology and the prosodic hierarchy. *The Phonology-Syntax Connection*, 109–125.
Hyman, Larry. 2009. How (not) to do phonological typology: the case of pitch-accent. *Language Sciences* 31. 213–238. DOI: https://doi.org/10.1016/j.langsci.2008.12.007
Hyman, Larry & Kemmonye Monaka. 2011. Tonal and non-tonal intonation in Shekgalagari. *Prosodic categories: production, perception and comprehension*, 267–289. DOI: https://doi.org/10.1007/978-94-007-0137-3_12
Inkelas, Sharon. 1998. The theoretical status of morphologically conditioned phonology: a case study of dominance effects. *Yearbook of Morphology 1997*, 121–155. DOI: https://doi.org/10.1007/978-94-011-4998-3_5
Inkelas, Sharon and Cheryl Zoll. 2007. Is grammar dependence real? *Linguistics* 45. 133–171. DOI: https://doi.org/10.1515/LING.2007.004
Inkelas, Sharon & William Leben. 1991. Where phonology and phonetics intersect: The case of Hausa intonation. In Mary Beckman & John Kingston (eds.), *Papers in Laboratory Phonology: Between the Grammar and Physics of Speech*, 17–34. Cambridge: Cambridge University Press. DOI: https://doi.org/10.1017/CBO9780511627736.002
Jannedy, Stefanie. 2007. Prosodic focus in Vietnamese. In Shin Ishihara, Stefanie Jannedy & Anne Schwarz (eds.), *Interdisciplinary Studies on Information Structure (ISIS)* 8, 209–230. Potsdam: Universitätsverlag.
Joseph, Umbavu & Robbins Burling. 2001. Tone correspondences among the Boro languages. *Linguistics of the Tibeto-Burman Area* 24(2). 41–55.
Jun, Sun-Ah. 1993. *The phonetics and phonology of Korean*. Ohio: Ohio State University dissertation.
Jun, Sun-Ah & Cecile Fougeron. 2000. A Phonological model of French intonation. In Antonis Botinis (ed.), *Intonation: Analysis, Modeling and Technology*, 209–242. Dordrecht: Kluwer Academic Publishers. DOI: https://doi.org/10.1007/978-94-011-4317-2_10

Karlsson, Anastasia, David House & Jan-Olof Svantesson. 2012. Intonation Adapts to Lexical Tone: The Case of Kammu. *Phonetica* 69(1–2). 28–47. DOI: https://doi.org/10.1159/000343169

Kenstowicz, Michael & Charles Kisseberth.1990. Chizigula tonology–the word and beyond. In Sharon Inkelas & Draga Zec (eds.), *The phonology-syntax connection*, 163–194. Chicago: University of Chicago Press.

Khan, Sameer. 2008. *Intonational phonology and focus prosody of Bengali*. Los Angeles: University of California dissertation.

Kubozono, Haruo. 1992. Modeling syntactic effects on downstep in Japanese. *Papers in Laboratory Phonology II*, 368–387. DOI: https://doi.org/10.1017/CBO9780511519918.016

Kügler, Frank. 2017. Tone and intonation in Akan. In Laura Downing and Annie Rialland (eds.), *Intonation in African Tone Languages*, 89–130. Berlin: Walter de Gruyter. DOI: https://doi.org/10.1515/9783110503524-004

Kügler, Frank & Stavros Skopeteas. 2006. Interaction of lexical tone and information structure in Yucatec Maya. *Proceedings of the Second International Symposium on Tonal Aspects of Languages (TAL-2)*, 77–82.

Kügler, Frank & Susanne Genzel. 2012. On the prosodic expression of pragmatic prominence–The case of pitch register lowering in Akan. *Language and Speech* 55(3). 331–359. DOI: https://doi.org/10.1177/0023830911422182

Kula, Nancy & Silke Hamann. 2017. Intonation in Bemba. In Laura Downing and Annie Rialland (eds.), *Intonation in African Tone Languages*, 321–364. Berlin: Walter de Gruyter. DOI: https://doi.org/10.1515/9783110503524-010

Laniran, Yetunde & George Clements. 2003. Downstep and high raising: interacting factors in Yoruba tone production. *Journal of Phonetics* 31(2). 203–250. DOI: https://doi.org/10.1016/S0095-4470(02)00098-0

Lehiste, Ilse. 2004. Bisyllabicity and tone. *Proceedings of the International Symposium on Tonal Aspects of Languages: With Emphasis on Tone Languages*, 111–114. https://www.isca-speech.org/archive/tal2004/papers/tal4_111.pdf.

Mahanta, Shakuntala, Kalyan Das & Amalesh Gope. 2016. On the Phonetics and Phonology of Focus marking in Boro. *Annual Meeting of Phonology 2015. Linguistic Society of America.* Vancouver, Canada. [S.l.]. DOI: https://doi.org/10.3765/amp.v3i0.3668

Ma, Joan, Valter Ciocca & Tara Whitehill. 2006. Effect of intonation on Cantonese lexical tones. *The Journal of the Acoustical Society of America* 120(6). 3978–3987. DOI: https://doi.org/10.1121/1.2363927

McCarthy, John & Alan Prince. 1993a. Generalized alignment. *Yearbook of Morphology 1993*, 79–153. DOI: https://doi.org/10.1007/978-94-017-3712-8_4

McCarthy, John & Alan Prince. 1993b. *Prosodic morphology: Constraint interaction and satisfaction*. Rutgers, NJ: Rutgers Center for Cognitive Science.

Myers, Scott. 1996. Boundary tones and the phonetic implementation of tone. *Studies in African Linguistics* 25(1). 29–60.

Myers, Scott. 2004. The effects of boundary tones on the f0 scaling of lexical tones. *International Symposium on Tonal Aspects of Languages: With Emphasis on Tone Languages*, 147–150.

Nespor, Marina. 1999. Stress domains. In Harry van der Hulst (ed.), *Word prosodic systems in the languages of Europe*, 117–159. Berlin: Mouton de Gruyter.

Nespor, Marina & Irene Vogel. 1986. *Prosodic phonology*. Dordrecht: Foris.

Nguyên, Thị & Georges Boulakia. 1999. Another look at Vietnamese intonation. *Proceedings of the XIVth International Congress of Phonetic Sciences*, 2399–2402.

Pierrehumbert, Janet. 1980. *The phonology and phonetics of English intonation*. Cambridge, Massachusetts: Massachusetts Institute of Technology dissertation.

Pierrehumbert, Janet & Mary Beckman. 1988. *Japanese tone structure (Linguistic Inquiry Monographs 15)*. Cambridge: MIT Press.

Poser, William. 1984. *The phonetics and phonology of tone and intonation in Japanese*. Massachusetts: Massachusetts Institute of Technology dissertation.

Potisuk, Siripong, Jack Gandour & Mary Harper. 1997. Contextual variations in trisyllabic sequences of Thai tones. *Phonetica* 54(1). 22–42. DOI: https://doi.org/10.1159/000262208

Prieto, Pilar. 2009. The intonational phonology of Catalan. In Sun-Ah Jun (ed.), *Prosodic Typology II: The Phonology of Intonation and Phrasing*, 43–80. Oxford: Oxford University Press. DOI: https://doi.org/10.1093/acprof:oso/9780199567300.003.0003

Rialland, Annie. 2007. Question prosody: an African perspective. In Tomas Riad & Carlos Gussenhoven (eds.), *Tones and tunes vol. 1: Typological studies in word and sentence prosody*, 35–64. Berlin, New York: Mouton de Gruyter. DOI: https://doi.org/10.1515/9783110207569.35

Sarmah, Priyankoo. 2004. *Some aspects of the tonal phonology of Bodo*. Hyderabad: Central Institute of English and Foreign Languages dissertation.

Selkirk, Elizabeth. 1978. On prosodic structure and its relation to syntactic structure. In Thorstein Fretheim (ed.), *Nordic Prosody II*, 268–271. Trondheim: TAPIR.

Shih, Chilin. (1987). *The phonetics of the Chinese tonal system*. AT&T Bell Labs Technical Memorandum.

Svetozarova, Natalia. 1975. The inner structure of intonation contours in Russian. *Auditory Analysis and Perception of Speech*, 499–510. DOI: https://doi.org/10.1016/B978-0-12-248550-3.50038-6

Voorhoeve, Jan. 1973. Safwa as restricted tone system. *Studies in African Linguistics* 4. 1–22.

Weidert, Alfons. 1987. *Tibeto-Burman tonology: A comparative analysis* 54. John Benjamins Publishing. DOI: https://doi.org/10.1075/cilt.54

Wheeldon, Linda & Aditi Lahiri. 2002. The minimal unit of phonological encoding: prosodic or lexical word. *Cognition* 85(2). B31–B41. DOI: https://doi.org/10.1016/S0010-0277(02)00103-8

Xu, Yi. 1997. Contextual tonal variations in Mandarin. *Journal of Phonetics* 25(1). 61–83. DOI: https://doi.org/10.1006/jpho.1996.0034

Xu, Yi. 1999. Effects of tone and focus on the formation and alignment of f0 contours. *Journal of Phonetics* 27(1). 55–105. DOI: https://doi.org/10.1006/jpho.1999.0086

Xu. Yi. 2013. ProsodyPro—A tool for large-scale systematic prosody analysis. France: Laboratoire Parole et Langage.

Zec, Draga. 2002. On the prosodic status of function words. *Working Papers of the Cornell Phonetics Laboratory* 14. 207–249.

Zsiga, Elizabeth. 1992. A mismatch between morphological and prosodic domains: evidence from two Igbo rules. *Phonology* 9(1). 101–135. DOI: https://doi.org/10.1017/S0952675700001512

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