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THE DISTRIBUTION AND REALIZATION
OF H TONES IN BENGALI

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ABSTRACT

The current study examines the realization and distribution of high (H) tones in Bengali across different sentence types and under varying focus domain sizes, to show that Bengali tonally marks three prosodic phrases above the word instead of two – Intonation Phrases (IP), Intermediate Phrases (ip), and Accentual Phrases (AP) – and that focus realization can be derived without the lexically-specified tonal morphemes or the additional stipulations on prosodic boundary placement proposed in previous models.

Keywords: Bengali, prosody, focus, intonation.

1. INTRODUCTION

Previous studies [5, 6, 8, 14, 16] claim that focus domains in Bengali are marked by a small prosodic unit bounded by a high (H) tone at its right (R) edge. This same unit is also claimed to mark edges of non-phrase-final content words, even under neutral focus. Using Bengali data gathered in a production experiment, the current study examines the realization and distribution of H tones claimed to be associated with various phrase edges and with focus domains, to investigate the prosodic structure and focus realization in the language.

1.1. Phrasing

According to previous studies [5, 6, 8, 9, 14, 16], Bengali assigns tones to stressed syllables of content words and to the R-edges of two prosodic units: the intonation phrase (I-phrase or IP) – roughly, the sentence – and a smaller phrase, slightly larger than a content word. This smaller phrase is given various labels, provided in Table 1.

Table 1: Prosodic units in various studies of Bengali.

| Study	Sentence-level prosodic unit	Phrasal-level prosodic unit
[12]	pause group	stress group
[5, 8, 16]	intonation phrase	phonological phrase
[6]	intonation phrase	accentual phrase
[9]	intonation phrase	intermediate phrase
[14]	intonation phrase	major phrase

In the model of Bengali intonation proposed in [5, 8, 14, 16], P-phrases (or MaPs) can either occur as a nucleus (*i.e.* the last tonally-marked P-phrase in the I-phrase) or in the head (*i.e.* prenuclear words). Head P-phrases bear at least one low pitch accent (L*), and at most one H boundary tone (H_P) at their R-edge. Nuclear P-phrases bear an I-phrase boundary tone (T_I) corresponding to the sentence type, and (when under focus) an H_P, in addition to a pitch accent (T*). The model in [5] claims that P-phrases may bear multiple pitch accents (see §2).

1.2. Focus

In addition to bearing the greatest metrical prominence, the R-edge of the focus domain is marked by H_P in the model in [5]. This predicts that expanding the focus domain will push the H_P boundary rightward. When the focused phrase occurs at the R-edge of an I-phrase, however, the H_P appears to be realized early (*i.e.* before the R-edge), allowing the T_I to be realized independently.

In [8], focus can be realized using two different patterns. Words attached to focus particles *-i* 'only, indeed' and *-o* 'even, also' are composed of two pitch accents: L* on the content word, H* on the focus particle, thus deriving a rising pitch pattern (L*…H*) superficially similar to the default pattern (L*…H_P) also described in [5]. The main difference between these two patterns arises when a focus particle attaches to a word in the middle of a focus domain. In such cases, it appears that the H tone occurs on the focus particle, even though the particle is not at the domain-R-edge (see Figure 1).

Figure 1: H* on the focus particle **-o 'also'**; *Sæmoli tSʰeleder [mere-o pʰeletSʰe]*_{FOC} 'Shyamoli **also** [beat]_{FOC} the boys [to death]_{FOC}', ([8], 30c, p. 137).
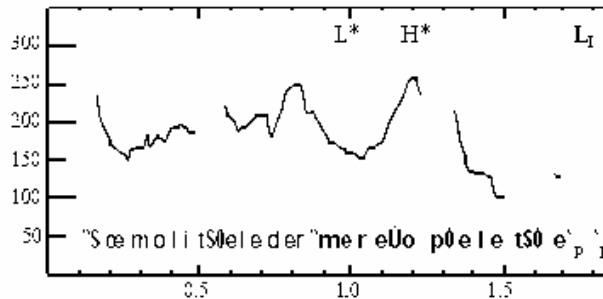
This analysis requires focus particles *-i* and *-o* to be lexically assigned an H*, as they are stressless and thus cannot independently attract postlexical pitch accents. This suggests that certain lexical items are specified for tone, even though Bengali is not a lexical tone language. A similar analysis proposed in [14] posits a tonal morpheme [H]_{FOC}, which aligns with the R-edge of focus domains.

2. QUESTIONS AND PREDICTIONS

Questions addressed by the current study, the predictions of previous studies, and a preview of the current model's findings are provided below:

(1) How many H tone types can be distinguished in terms of phonetic realization and syntactic distribution?

> Predictions of [5, 6, 14, 16]: two (H_I and H_P, H% and Ha, or H and $[H]_{FOC}$)
> Predictions of [8, 9]: three (H_I, H_P, H* or H%, H-, L*+H)
> **Current model**: five (H%, H-, Ha, L*+H, H*)

(2) Does the number of pitch accents correspond to the number of boundary tones?

> Predictions of [5, 16]: not always
> Predictions of [6, 8, 9, 14]: yes
> **Current model**: yes

(3) Does the H tone associated with focus move to the right as the focus domain expands rightward?

> Predictions of [5, 8, 14, 16]: yes (excluding focus particles)
> **Current model**: no.

3. EXPERIMENTAL METHOD

The current study analyzes data gathered from 18 native Bengali speakers (9 male, 9 female) in an ongoing production experiment. The speakers, ranging in age from late teens to mid-60s, were all born in Bengali-speaking regions of South Asia, and were educated in both Bengali and English.

Each speaker read 57 sentences aloud into a hand-held microphone connected via a USB cable to a laptop. The sentences were mostly made up of vowels and sonorant consonants. Their pragmatic, semantic, syntactic, and phonological properties were manipulated to test for: (a) different boundary tones, by using particular particles (*i.e.* focus clitics, interrogative particles) and punctuation (*e.g.* commas, question marks), and (b) the realization of focus domains, by using particular words of varying size and by using context sentences (*i.e.* preceding wh-questions eliciting focus on particular constituents).

Recordings were made in WaveSurfer [15], and pitch events were analyzed in Praat [3] using a transcription system based on ToBI [1], adopting the framework of intonational phonology [2, 10, 11]. This preliminary transcription system, known as B-ToBI (Bengali Tones and Break Indices), is described in [7].

4. DATA AND ANALYSIS

As described in previous studies, the basic sentence in Bengali is composed of a sequence of phrases characterized by a pitch rise, with each phrase roughly spanning a content word and any adjacent function words. The initial low pitch of each phrase is associated with the stressed (*i.e.* initial) syllable of the content word, and the high pitch is associated with the phrase's R-edge. Additional tones occur at the edges of larger units.

Further details regarding H tones are provided below; the current study uses these H tone data to propose (a) a prosodic structure that includes three tonally-marked prosodic units, and (b) an analysis of focus that avoids lexical tones and prosodic boundaries at the R-edges of focus domains characterized by L-edge prominence.

4.1. Phrasing

All intonational phonology models of Bengali, including the current study, describe different types of H boundary tones corresponding to the different levels of phrasing. The current data suggest that, apart from the sentence level H boundary tone (H_I or H%), there are two additional H boundary tones (*i.e.* H- and Ha), presumably corresponding to the edges of two different prosodic units. Furthermore, what was previously described as an H tone marking the R-edge of a focus domain (H_P, H*, $[H]_{FOC}$) can be reanalyzed as the high component of a rising pitch accent (L*+H), described in §4.2. In contrast to the two or three H tones predicted by earlier models (see §2), the current model posits four high/rising tones (H%, H-, Ha, L*+H) that can be distinguished both by their phonetic realizations and by their syntactic-semantic distributions.

4.1.1. Accentual phrase H boundary tone (Ha)

Previous analyses of Bengali intonation describe a high boundary tone following each non-phrase-final content word, although they disagree on its label. The current model concurs with the model in [6] in suggesting it is an AP boundary tone (Ha), as there is one boundary tone per non-phrase-final pitch accent – something not predicted by [5, 16] (see §2). It seems that Bengali (like Japanese) has a small prosodic unit with the pitch accent serving as its head and a boundary tone marking its R-edge. As shown in Figure 2, the pitch of each Ha tone is lower than that of the preceding Ha tone.
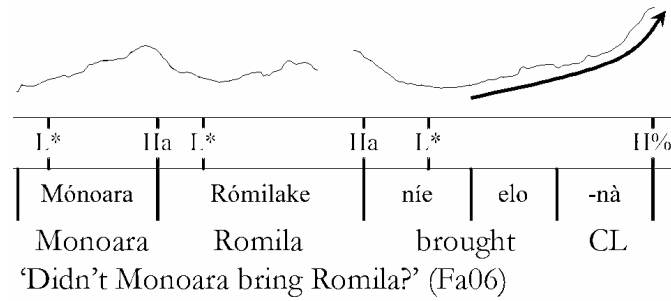
Figure 2: Example pitch track of five Ha tones, each realized as a steady rise from the L* to the AP-R-edge. Note how the Ha tones follow a line of downtrend.
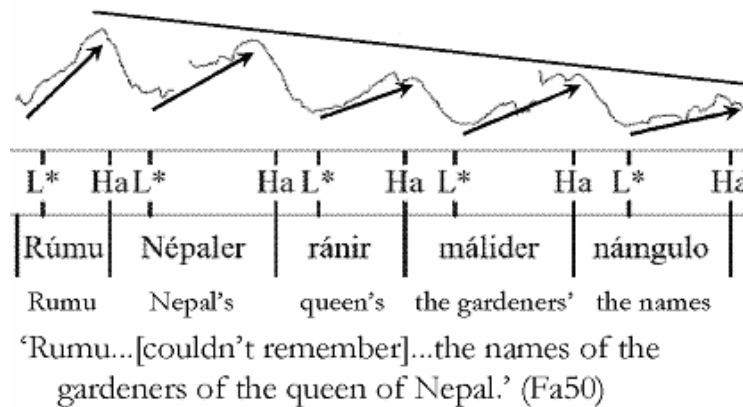
4.1.2. Intonation phrase H boundary tone (H%)

The current data show the existence of a high IP boundary tone (H%) associated with certain interrogative questions and polite requests, confirming the findings of [5, 8, 9, 12]. The boundary tone causes the preceding pitch to rise steadily starting from the IP-final pitch accent, followed by a sharp rise on the final syllable (see Figure 3).

Figure 3: Example pitch track of an H% tone, realized as a steady rise from L* followed by a sharp final rise.

L*	Ha	L*		Ha	L*	H%
Mónoara		Rómilake			níe	elo	-nà
Monoara		Romila			brought	CL

'Didn't Monoara bring Romila?' (Fa06)

4.1.3. Intermediate phrase H boundary tone (H-)

A third boundary tone type, not explicitly described in previous models, is the ip boundary tone. Three tones (L-, H-, LH-) are found to mark the R-edge of the ip, the prosodic unit between the IP and AP levels. As a comparison with H% and Ha, an example of H- is shown in Figure 4.

Figure 4: Example pitch track of H- compared to Ha. The topic '[As for] Mira's grandfather' ends in a sharp rise on the final syllable [na], marking the ip-R-edge.

L*		Ha	L*	H-
Mírar			nána	
Mira's			grandfather	

'[As for] Mira's grandfather…' (To34)
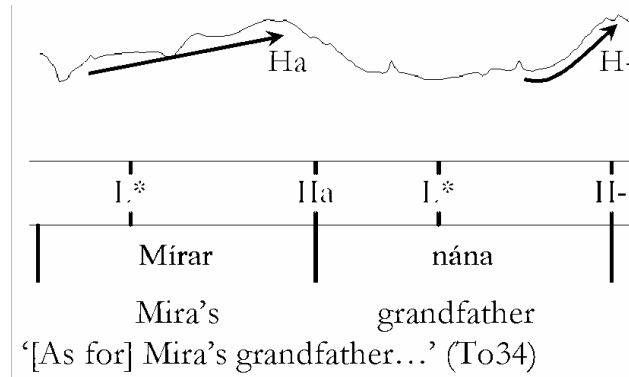
Note how the ip tone, unlike the IP and AP tones, does not cause the preceding low pitch (due to the L*) to interpolate towards the high tone (H-), until the very last syllable of the phrase. LH- and L- also obey this locality constraint, suggesting that a sharp contour localized on the final syllable can help distinguish ip tones from IP and AP tones.

4.1.4. Phrasal properties

In addition to being phonetically distinct, the three H boundary tones seen in the data (H%, H-, Ha) appear to demarcate prosodic units of different sizes and different syntactic structures. While the IP tone H% marks the R-edge of questions (*i.e.* complete sentences), the ip tone H- marks the R-edge of smaller syntactic constituents (*e.g.* topics, PPs). The AP tone Ha marks the R-edge of a much smaller unit, often composed of one word. When an AP is composed of multiple words, the words often do not form a syntactic constituent (*i.e.* the AP is largely syntax-insensitive). Furthermore, while IPs and ips are not sensitive to the number of pitch accents they contain, APs, by definition, must contain exactly one pitch accent. This suggests that IPs and ips are sensitive to syntactic structure, while APs are derived from metrical structure.

4.1.5. Summary of phrasing observations

As the current data reveal three disjuncture types distinguishable in the realization of the H tone of each category (H%, H-, Ha), and three phrase types with different syntactic and metrical properties, the current model expands the previous two-level system of Bengali prosodic structure to three levels (IP, ip, AP), as shown in Table 2.

Table 2: Mapping of the prosodic units in previous models of Bengali to those of the current model.

[5, 8, 16, (14)]	Current model	[6, 9, (12)]
I-phrase (IP)	IP	IP (pause group)
P-phrase (MaP)	ip	
	AP	AP (ip, stress group)

4.2. Focus

Most previous studies describe focus realization as a combination of a low pitch accent (L*) on the stressed syllable and an H tone on the domain-R-edge (H_P, H*, or $[H]_{FOC}$), thus "framing" the focused constituent with the two tones. The data collected in the current study confirm that the initial stressed syllable of a focused constituent is associated with low pitch, as in Figure 5.

Figure 5: Pitch track of a focused word 'Nina$_{ACC}$' bearing an F_0 maximum on the 2nd and 3rd syllables [nake], up to the R-edge. The L*…Ha pattern (with Ha downtrend), represented by the dotted line, would be expected if 'Nina$_{ACC}$' were under neutral focus.

'(No, no)…Monoara brought *Nina*.' (Ro22)
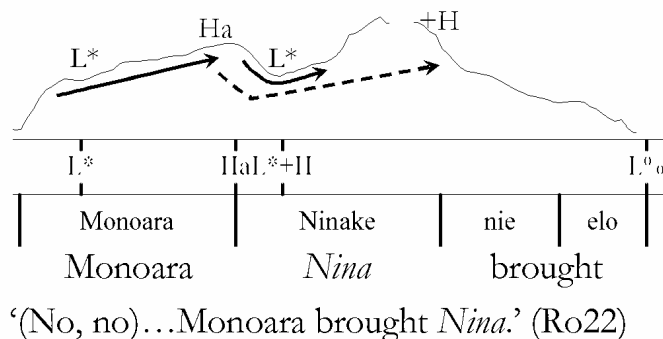
However, the observed data show that the H tone associated with focus is in fact *not* a reliable marker of the domain-R-edge. When the focus domain is expanded, the H tone consistently appears one or two syllables to the right of the stressed (*i.e.* initial) syllable of the focused constituent, regardless of the distance to the domain-R-edge (see Figure 6), suggesting that the H tone is somehow associated to the stressed syllable, and not the domain-R-edge. The R-edge of the focus domain is not marked by a boundary tone in the current model, confirming the analysis in [9], but deviating from the descriptions of focus in [5, 8, 14, 16].

Figure 6: Pitch track of a focused 4-syllable word with F_0 maximum on 2nd and 3rd syllables [mila]. The domain-R-edge is unmarked. Microprosody due to [k].

'Monoara brought *Romila*.' (Re23)
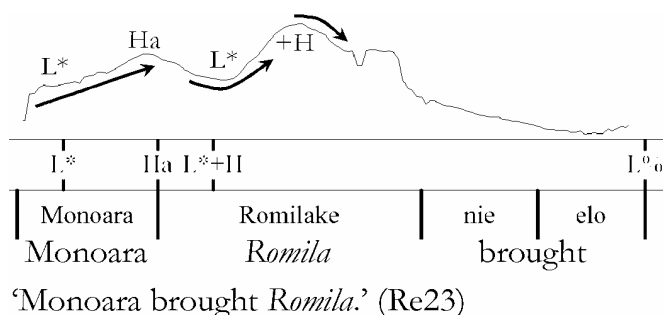
The data suggest that the H tone associated with focus is not aligned with the focus domain's R-edge. Instead, it is part of a rising pitch accent (L*+H), which occurs on most focused words. The focus domain's R-edge is unmarked. Dissociating the H tone from the focus domain's R-edge explains the tone's "early" realization in Figure 1 and Figure 6, and when IP-final (see §1.2). Furthermore, this analysis avoids two problematic aspects of earlier models; there is no need to posit either (a) a lexically-specified H tone (H*, [H]$_{FOC}$) for focus domains, as was done in [8, 14], or (b) a prosodic boundary at the *right*-edge of a focus domain characterized by *left*-edge prominence, a problem more thoroughly discussed in [14].

5. CONCLUSIONS

The realizations and distributions of high (H) boundary tones in Bengali provide evidence for three levels of prosodic phrasing above the word (IP, ip, AP), as has been shown in [4, 13] for Farsi and in [6] for Basque, in contrast to the two levels posited by earlier studies of Bengali prosody.

Additionally, varying the size of the focus domain reveals that focus is not realized in Bengali by a high boundary tone at the domain's R-edge, but by a rising pitch accent (L*+H), keeping consistent with the analysis in [9]. This analysis effectively avoids the need to posit (a) a restricted set of particles with lexically-specified tones in a non-lexical tone language, or (b) prosodic boundaries marking the right-edge of a focus domain characterized by left-edge prominence.

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