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BENGALI INTONATIONAL PHONOLOGY*

This paper proposes a phonological analysis of the Bengali intonational system, using a descriptive framework developed by Pierrehumbert (1980) and others. Our analysis bears on a number of theoretical points. We argue that the Bengali facts support a typology of intonational tones that includes only pitch accents and boundary tones, and that the docking sites for boundary tones are the phrase edges provided under the theory of the Prosodic Hierarchy (Selkirk 1980). We show that Bengali intonational contours are governed by the obligatory Contour Principle (OCP), which forbids adjacent identical tones. Underlying contours that violate the OCP are converted to permissible surface forms by a phonological rule. We also bring Bengali data to bear on a long-standing controversy concerning phrasal stress: Bengali can be shown to have a default, phonologically assigned phrasal stress pattern; thus phrasal stress assignment cannot be reduced exclusively to focus and other semantic factors.

1. INTRODUCTION

Intonation is studied in several areas of linguistics, including pragmatics, semantics, syntax, phonology, and phonetics. This paper is about the phonology of intonation in Bengali. We seek to describe in formal terms the set of Bengali intonation contours and to account for how the various contours are aligned with a given text.

Our results bear on the formal theory of intonation developed in work by Liberman (1975), Bruce (1977), Pierrehumbert (1980), Beckman and Pierrehumbert (1986) and others in this research tradition. We address three areas:

BOUNDARIES AND BOUNDARY TONES: Our results support the claim of Beckman and Pierrehumbert (1986) that the "phrase accent" of Bruce (1977) and Pierrehumbert (1980) can be reanalyzed as a BOUNDARY TONE, and that the set of intonational tones thus may be restricted to just pitch accents and boundary tones. We also argue, using evidence from the segmental phonology, that the constituency relevant to boundary tone placement is that provided under the theory of the PROSODIC HIERARCHY (Selkirk 1980, Nespor and Vogel 1986).

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THE OCP IN INTONATIONAL PHONOLOGY: We show that the inventory of available intonation contours in Bengali can be insightfully accounted for by positing that intonational tunes in this language obey the Obligatory Contour Principle. We posit a phonological rule in Bengali whose function is to repair OCP violations.

PHRASAL STRESS: We argue that Bengali has a true phonological rule of phrasal stress assignment applying in neutral focus contexts. This constitutes evidence against the view held by Bolinger (1972) that all phrasal stress assignment is non-phonological in nature, reflecting only semantic factors.

To our knowledge, this is the first attempt at formally characterizing intonation in Bengali, and as such is somewhat tentative. Our data are based on Lahiri's speech, checked against that of three other native speakers of Calcutta Bengali. Earlier work in this area (Chatterji 1921, pp. 20–21; Ferguson and Chowdhury 1960, pp. 25–28) is fairly sketchy, but appears to describe patterns fairly similar to what we present below.

2. THEORETICAL FRAMEWORK

We first describe the framework we adopt for the formal description of intonation. The ideas we present are taken from work by Liberman (1975), Bruce (1977), Pierrehumbert (1980), Beckman and Pierrehumbert (1986), and elsewhere in the substantial research tradition on intonation. The reader should note that what follows is *not* a direct summary of the works just cited; rather, we present what we take to be the crucial leading ideas. In addition, the notation we will use is our own, which we have developed in the interest of greater clarity and explicitness.

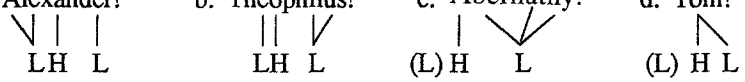
2.1. *Tune and Text*

Intonation contours can be usefully analyzed as TUNES: that is, as formal entities separate from the linguistic text. The tunes reside in an "intonational lexicon" and convey (often highly elusive) intonational meanings. At a particular postlexical level of the grammar, called "intonated surface structure" by Selkirk (1984), linguistic texts are paired with particular tunes. Rules of the phonology then align the tune and the text with autosegmental association lines. Following the phonology, phonetic rules compute actual pitch trajectories from the phonological representation.

At the phonological level, tunes consist of sequences of tones, arrayed on a separate tonal tier as in tone languages (Goldsmith 1976). To give an oversimplified example, a tune of English that is used to express

surprise or emphasis could be analyzed as the tonal sequence L H L (Low-High-Low). It is linked to four different texts as follows:

(1)a. Alexánder! b. Theóphilus! c. Ábernathy! d. Tóm!

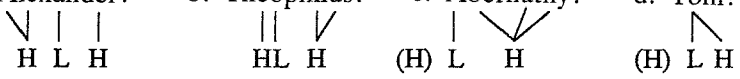


Based on these data, we can posit the following rules to associate the tones of the tune to the syllables of the text. Note that these rules are purely illustrative; more sophisticated apparatus will be introduced as we proceed.

(2)a. Associate H to the main stressed syllable.
b. Associate the first L to syllables preceding the main stress, if there are any.
c. Associate the second L to all syllables following the main stress; if there are none, associate L to the same syllable as the H tone.

Similar rules can associate other tunes to the same texts. For example, a question tune, H L H, could be associated to the texts of (1) as follows:

(3)a. Alexánder? b. Theóphilus? c. Ábernathy? d. Tóm?

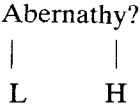


It is this relative freedom of combination that justifies the formal separation of tune and text.

2.2. *Phonetic Underspecification*

The representations of (1) and (3) would count as correct depictions of the relevant contours only if we adopted an extreme degree of idealization. For example, *Abernathy* with question intonation usually does not receive a low pitch on *Ab* followed by a high plateau on *bernathy*, but rather displays a continuous rise from *Ab* to the end of the word. Liberman (1975) and Bruce (1977) suggested alternative representations that can be more directly related to the phonetic facts. In these representations, tones occur only at the crucial defining points of a contour, with rules of phonetic interpolation determining the course of pitch between them. Under this view, question intonation on *Abernathy* might be represented as follows:

(4) Abernathy?



The rules of interpolation allow for various ways of connecting tones in various contexts (straight line, sag, etc.). Since some kind of phonetic rules are needed to specify the shape of the output pitch curves, little seems to be gained by spreading the tones onto syllables where they are not phonologically significant.

2.3. *Phonemicizing the Tone Levels*

Pierrehumbert (1980) made the striking claim that the number of contrastive tone levels in English is not four (as in Trager and Smith (1951), Liberman (1975), and much other work) but only two, H and L. The large array of surface tone heights is predictable, given an adequate set of phonetic pitch assignment rules.

The case for Pierrehumbert's phonemicization is that it resolves a serious difficulty faced by systems with more tones, originally pointed out by Bolinger (1951). A system with, say, four tones analyses certain pitch contours as distinct when they arguably are not. For example, a contour like 1 4 1 can have essentially the same meaning and usage as a 1 3 1 contour, differing only in degree of emphasis. A two-tone phonemicization represents both as LHL, allowing the paralinguistic factor of overall pitch range to determine the actual phonetic values.

The rules for pitch assignment in a HL system can be quite complex, and dramatic in their effects: for instance, a L tone will sometimes be realized on a higher pitch than a H elsewhere in the same utterance. For detailed accounts, see Pierrehumbert (1980) and Liberman and Pierrehumbert (1984).

Our results so far suggest that the Bengali intonational system can likewise be analyzed as having two tones, H and L. The same reasoning applies as for English. (a) There are no clear cases in which more than two heights contrast, when all other factors (i.e. stress, phrasing, and overall pitch range) are set constant. (b) The same overall tonal contour can be produced with many different pitch ranges; to phonemicize these as extra tone levels would fail to provide a unitary characterization for what is essentially the same contour.

2.4. *The Structure of the Tune*

An important goal of intonational phonology is to devise general rules of tune-text association that can apply for all the tunes of a language. Beyond this, we hope to develop general principles of tune-text association that are valid cross-linguistically. The work cited above involves interesting proposals in this direction.

In order for rules of tune-text association to apply to whole classes of tunes, it is necessary to give tunes an internal structure that guides association. We follow here proposals made in Pierrehumbert (1980), Beckman and Pierrehumbert (1986), and Pierrehumbert and Beckman (1988), which works we will abbreviate as PB. PB propose to classify tones according to the role they play in the system. Their typology of tones is as follows.

PITCH ACCENTS are tones that get linked to stressed syllables. Formally, they are annotated with an asterisk (H*, L*).

A special kind of pitch accent in PB's system is the BITONAL pitch accent, which in English may take the form L* + H, H* + L, L + H*, or H + L*. In some bitonal pitch accents (L* + H, H + L*, L + H*), the starred tone falls on a stressed syllable, while the other tone specifies a rapid pitch change just before or after the stress. For example, L* + H indicates the so-called "scooped" pitch accent (Beckman and Pierrehumbert 1986, p. 281): low on the stressed syllable, with a rapid rise just after it. In certain other bitonal pitch accents (English H*+L), the L tone serves a purely diacritic function; it is not phonetically realized, but triggers downstep (a lowering in pitch) of following H tones.

In Bengali, it appears that there are no overtly realized bitonal pitch accents. Like PB, however, we adopt below one of the bitonal accents (L + H*) for the description of downstep.

The next kind of tone in the PB system is the BOUNDARY TONE, marked T%. In our interpretation, such a tone "links to a boundary" rather than to a syllable, meaning that the pitch target is aligned with the actual edge of a phrase rather than a particular syllable. Boundary tones allow for phonological representations that are closer to phonetic form. For example, when *Abernathy* is said with question intonation, there is a brief period of fairly flat low pitch on the first syllable *Ab*, during which the low tone hits its proper value. But there is no corresponding flat H region on the last syllable *thy*; rather, pitch keeps climbing until phonation has ceased. Placing the H tone on the right boundary, as in (5b), depicts in a natural way the fact that pitch rises to the very end.

(5)a. *Tones Linked Always to Syllables*
(hypothetical form)

[Abernathy?]
| |
L* H

(5)b. *Boundary Tone Representation*
(possible English intonation)

[Abernathy?]
| |
L* H%

PHRASE ACCENTS, notated H^-, L^-, were originally proposed by Bruce (1977) in an analysis of Swedish. In English (Pierrehumbert 1980), the phrase accent is an extra tone found between the rightmost pitch accent and the final boundary tone. Its alignment in time is somewhat variable, and it controls the pitch in the region between the last accent and the boundary tone.

Beckman and Pierrehumbert (1986) propose to analyze the phrase accent as a kind of boundary tone. Their proposal is as follows. The domain of a full intonational tune (i.e. the text it is lined up with) is called the INTONATIONAL PHRASE (IP). Each Intonational Phrase is divided up, more or less on syntactic grounds, into one or more INTERMEDIATE PHRASES, which we will abbreviate *ip*.

Under this theory, the old "phrase accent" is now the boundary tone of the Intermediate Phrase, while the old "boundary tone" is now the boundary tone for the Intonational Phrase. The overall scheme works as follows:

(6) $[_{IP}\ [_{ip}\ \sigma\ \acute{\sigma}\ \sigma\ \ \acute{\sigma}\ \sigma\ ]_{ip}\ [_{ip}\ \sigma\ \ \acute{\sigma}\ \sigma\ ]_{ip}\ [_{ip}\ \sigma\ \acute{\sigma}\ \sigma\ \acute{\sigma}\ \sigma\ ]_{ip}\ ]_{IP}$

| | | | | | | | | | | | | |
T* T* T% T* T% T* T* T% T%

PB present two arguments for this idea. First, it lets them describe previously problematic cases in which tonal excursions occur that are more complex than can be described with the pitch accents alone, but do not involve the full phonological disjuncture and tonal possibilities found at Intonational Phrase breaks. Second, the new account provides an elegant rationale for why a richer variety of pitch contours is possible after the rightmost pitch accent: it is only here that the phrasing assigns two consecutive right brackets, hence two boundary tones.

Note that in (6), the last two boundary tones are linearly ordered at the very end of the segmental material in the utterance. Strictly speaking, such an ordering should be impossible, since two different tones cannot be executed simultaneously. In actual practice, such sequences of boun-

dary tones are executed as fairly rapid pitch excursions during the final portion of the text. In other words, the phonetic alignment deviates slightly from the abstract phonological specification, in order to make both boundary tones realizable. We suggest below that essentially the same phenomenon occurs in Bengali.

Our description of Bengali roughly adheres to PB's overall scheme for the description of tunes, but with some differences.

First, we posit that some Bengali contours have two tones linked to the Intonational Phrase boundary, as in (7):

(7)a. $]_I$ b. $]_I$

L H H L

As in English, sequences of final boundary tones are rendered as a rapid pitch excursion, close to the right edge of the phrase. In practice, this usually places the entire excursion on the final syllable.

Second, in describing levels of phonological phrasing, we draw on an independent research tradition on phrasing, the theory of the Prosodic Hierarchy (Selkirk 1980, Nespor and Vogel 1986). This theory, which is based on evidence from junctural phenomena rather than intonation, also posits a level of phrasing immediately subordinate to the Intonational Phrase, namely the PHONOLOGICAL PHRASE. It is an unsettled issue whether the Intermediate Phrase and the Phonological Phrase are the same thing.[1] In the case of Bengali, we will show below that the exact same phrases that control juncture effects also control the intonation pattern. For this reason, we use the term Phonological Phrase, to emphasize this identity.

A notational change we adopt is intended to distinguish the boundary tones that occur at different phrasal levels. We will notate boundary tones occurring at Phonological phrase boundaries as T_P, and boundary tones occurring at Intonational Phrase boundaries as T_I. As we will see, the distribution between T_P and T_I is a crucial one in Bengali.

Pierrehumbert and Beckman (1988) distinguish T_P and T_I by beefing up the theory of autosegmental association, so that tones can be linked directly to high-level nodes in the hierarchy of phrasing. Since nothing in what we will say bears on this proposal, we use the tonal diacritics for brevity.

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[1] Indeed, Gussenhoven (1990) argues that intonational and prosodic domains need not be isomorphic, and that instead intonational domain boundaries need only coincide with some prosodic boundary. However, to our knowledge such mismatches do not occur in Bengali.

A final difference between our proposed Bengali structures and PB's English ones is that in Bengali, not all positions are structurally obligatory. Some Bengali tunes have four tones: T*, T_P, and two T_I; but others have just T* and a single T_I. Because Bengali tunes may include so few tones, many brackets in prosodic structure are not marked intonationally. /T* T_I/ appears to be the minimum permissible phonological specification for a Bengali nucleus.

2.5. *Generalized Rules of Tune-Text Association*

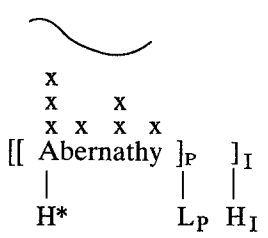
Given the enriched structure of the tune that we assume, the actual phonological rules for tune-text association are very simple:

(8)a. Pitch accents associate with stressed syllables within their phrasal domain.

b. Boundary tones associate with the boundary for which they are diacritically marked.

These rules are illustrated below with an example in which a declarative tune with continuation rise is associated with the text *Ábernàthy*. This short text constitutes both a Phonological Phrase and an Intonational Phrase, following general principles of Prosodic Hierarchy theory. Levels of stress are indicated in grid notation (Prince 1983).

(9)



Note that because the text ends at the right end of both a Phonological Phrase and an Intonational Phrase, there are two boundary tones. These are implemented as a rapid excursion from L to H, near the end of the text.

Rule (8a) is ambiguous, in that it does not dictate the outcome when there is more than one stressed syllable available to which a pitch accent could be associated. Here, the correct outcome is determined by stress levels, following the principle (10), from Pierrehumbert (1980, p. 37):

(10) Given a choice of where to link a pitch accent, link it with the strongest stress of its phrasal domain

This principle forces the H* pitch accent to be aligned with the first syllable rather than the third, which bears only secondary stress. In general, because of principle (10), the main stress of a phrase forms the central linking point for aligning a tune.

To sum up, in our analysis of Bengali we adopt a theory of intonational structure that posits a sequence of one or more Phonological Phrases, grouped into an Intonational Phrase. Each Phonological Phrase may contain one or more pitch accents (T*), and may end in a boundary tone (T_P). The Intonational Phrase supplies one or two additional boundary tones, labeled T_I. Tones may be H or L, and the actual pitch of a H or L is determined by phonetic rules.

3. Bengali Stress

Since the docking sites for pitch accents are stressed syllables, the first task in an intonational analysis is to determine where stress is located. For Bengali, word stress follows a very simple rule (cf. Chatterji 1921, Klaiman 1987):

(11) *Word Stress*
Stress the initial syllable of a word.

This rule is inviolable. Compound words also have their strongest stress on their initial syllables. There may also be a weaker stress on the initial syllable of their second member, but this is hard to hear.

For Bengali phrasal stress, we adopt the rules under (12)–(13), which assign initial prominence to Phonological Phrases (hereafter, P-phrases) and final prominence to Intonational Phrases (hereafter, I-phrases).

(12) *P-phrase Stress*
Within the P-phrase, the leftmost non-clitic word is the strongest.

(13) *I-Phrase Stress*
a. A P-phrase bearing narrow focus receives the strongest stress of its I-phrase.
b. Under neutral focus, the rightmost P-phrase within the I-phrase is the strongest.

Some examples of how our rules apply appear in (14).

(14)a.

x
x x
x x x x
x xx x x xx x x xx

[[šæmoli]$_P$ [ram-er bari]$_P$ [ḍ^{h}ukeč^{h}ilo]$_P$]$_I$

Shamoli *Ram-'s house* *entered*

Shamoli entered Ram's house (neutral focus)

b.

x
x x x
x xx x xx x x xx

[[šæmoli]$_P$ [or bari]$_P$[ḍ^{h}ukeč^{h}ilo]$_P$]$_I$

Shamoli *his/her* *house* *entered*

Shamoli entered his/her house (neutral focus)

c.

x
x x x x
x xx x x xx x x xx

[[šæmoli]$_P$ [ram-er bari]$_P$ [ḍ^{h}ukeč^{h}ilo]$_P$]$_I$

Shamoli *Ram-'s house* *entered*

Shamoli entered *Ram's house*

Example (14a) illustrates the application of rules (12) and (13b). Case (14b) shows how clitic-like words such as *or* 'his/her' fail to get stressed in P-phrase initial position (cf. (12)). Case (14c) shows how focused P-phrases attract main stress.

Our rules are based on the view that languages have normal, default stress rules, which may be overridden in cases of narrow focus. Arguments for this general view of phrasal stress and focus may be found in Ladd (1980, pp. 50–99), Culicover and Rochemont (1983), and below. The term "focus" is hard to define precisely. Our usage basically follows Gussenhoven (1984, pp. 17–18, 65–68), except that we use "neutral focus" to describe sentences that Gussenhoven would describe as consisting entirely of focused material.

Note that predicate-argument structure (Schmerling 1976, Selkirk 1984, Gussenhoven 1984) does not seem to play a role in Bengali stress. Whereas in a German sentence like *Ram hat Schä̃moli gesehen*, 'Ram saw Shamoli', the argument *Schämoli* takes stress over the predicate *gesehen*; in the Bengali version *Ram šæmoli-ki dék^{h}lo*, stress goes on the rightmost P-phrase *dek^{h}lo*, obeying a purely phonological generalization (for discussion of P-phrasing, see Section 9).

A final caveat: stress in Bengali is usually quite weak phonetically,

sometimes to the point of being almost inaudible. Our stress rules are supported by two types of evidence. First, in emphatic speech, the stresses are stronger and more audible, and occur where the rules above predict. Second, the stress rules are supported by the internal coherence that they provide to the intonational system: all of the various intonational contours we discuss below link up to texts in essentially the same way. If we didn't posit stress rules for Bengali, the fact that all contours are aligned identically would go unaccounted for. That is, in Bengali as in other intonation languages (cf. Ladd (1980, pp. 34–49) for English, Dell (1986, pp. 65–71) for French), stress serves as the basic organizing principle for tune-text association.

4. Basics of Bengali Intonation: H_P vs. H_I

Intonation scholars often divide contours into two parts:

(15)a. Nucleus: the main stressed syllable plus everything after it
b. Head: everything before the main stressed syllable

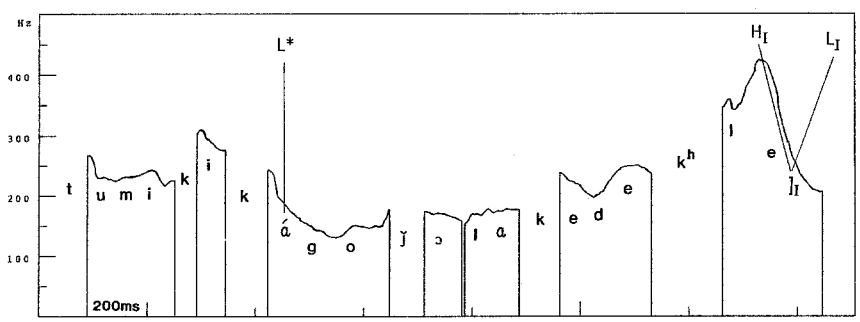
This usage follows among others Ladd (1980, p. 16). The head/nucleus distinction is not crucial to our analysis, but will serve as useful descriptive terminology. We cover nuclei in the next four sections, and the head in Section 8.

The central aspect of our analysis is the distinction between T_P and T_I, that is, boundary tones linked to a P-phrase boundary vs. an I-phrase boundary. We begin by motivating this distinction.

4.1. *Yes/No Questions and H_I*

The following example illustrates the Bengali nucleus most often used for yes/no questions.

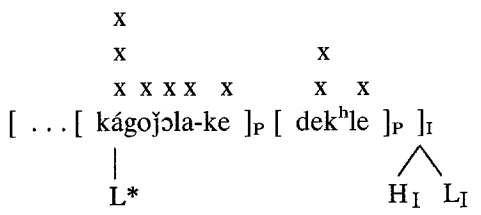
(16) tumi-ki *kágoǰɔla-ke* dek^{h}le?
you Q-part. newspaperman-obj. saw
Did you see the *newspaperman*? (yes/no question nucleus)



This sentence has narrow focus on *kagoǰɔla-ke* 'the newspaperman', so that the first syllable of this word, *ka*, gets the main stress of the sentence. In the yes/no nucleus, the main stressed syllable gets a low pitch, and pitch then rises smoothly to the final syllable (here *le*), whereupon it falls again quite rapidly. The first syllable in this example is quite stressless.[2]

We phonemicize the yes/no question contour as L* H_I L_I, giving the nucleus of (16) the structure of (17). We include a metrical grid to show the stress pattern.

(17)



The L* docks onto the main stress, accounting for its especially low pitch. Phonologically, the H_I L_I sequence lodges entirely at the end of the utterance. As in the English example of (9), this is interpreted phonetically as an instruction to reach a high peak followed by a final low value, fairly rapidly. The gradual, then accelerated rise from L* to H_I is computed by phonetic rule.

4.2. *The Focus Nucleus and H_P*

The contour we will call the focus nucleus is shown in (18).

(18) ami *kágoǰɔla-ke* dekʰlam
I newspaperman-obj. saw
I saw the *newspaperman*. (focus nucleus)

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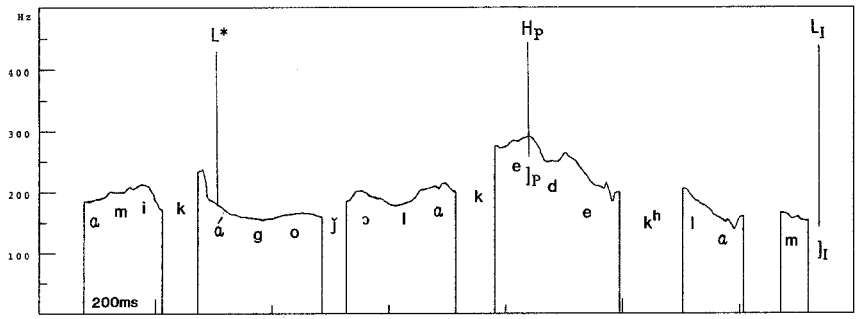
[2] A little guidance for the uninitiated in reading pitch tracks may be useful. (a) Voiceless obstruents often perturb pitch: pitch is lowered just before a voiceless obstruent, and raised just after it. In (16), these effects can be seen for /k/ and /kʰ/. (b) Pitch is often lowered during a voiced obstruent, as in the /g/ of *kagoǰɔla* and the /d/ of *dekʰle*. Neither one of these perturbations seems to be phonologically relevant in Bengali, though in historical change these effects have led to phonemic tone in other languages. (c) At least in Bengali, the phonetic target for a pitch accent is often reached rather late in the accented syllable. This is true, for instance, of the accented syllable /ka/ in (16). Indeed, because voiced obstruents lower pitch, it is the /g/ of the second syllable that receives that actual pitch minimum.

Segment labeling of the pitch tracks was carried out using the original waveforms, which are not included here.



The focus nucleus is used for statements in which a particular constituent is emphasized; in this case, the NP *kagoǰɔla-ke*. The focus nucleus is like the yes/no question nucleus in having a L* tone on the main stress of the phrase, and in having an overall rise-fall shape. But the H tone in the focus nucleus is aligned differently. In (18), the H falls near the end of the focused constituent, *kagoǰɔla-ke*, rather than near the end of the sentence as in (16).

We have gathered many examples to determine how the H tone of the focus nucleus is aligned. Our data suggest that the H tone always appears on or near the right edge of a focused constituent. In other words, the H of the focus nucleus serves as a *focus marker*, somewhat like the phrase accent proposed for Swedish by Bruce (1977).

To account for the data, we make two assumptions. First, we posit as a first approximation that the rules for phonological phrasing in Bengali always make a focused syntactic constituent into a single P-phrase. That focus can determine phonological phrasing is by now well documented; see Poser (1984, p. 107) for Japanese, Inkelas (1988) for Hausa, Cho (1990) for Korean, Condoravdi (1990) for Modern Greek, Kanerva (1990) for Chichewa, and Selkirk and Shen (1990) for Shanghai Chinese. In addition, we will present evidence below from the segmental phonology to support our claim.

We also assume that phonemically, the focus nucleus is L* H_P L_I. Tune and text are linked as follows: L* goes on the nuclear stress, H_P is linked to the right edge of the P-phrase that contains the L*, and L_I is linked to the right $]_I$ boundary:

(19)

[. . . [kágoǰɔla-ke]$_P$	[dek^{h}lam]$_P$]$_I$
|	| |
L*	H_P L_I

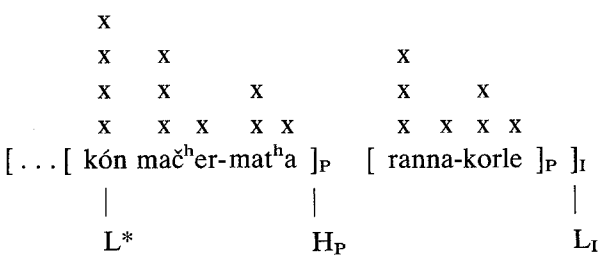
Phonetic rules compute smooth, slightly drooping curves between the tones.

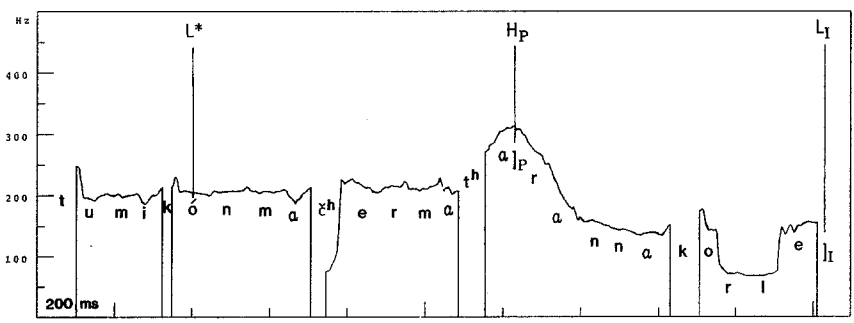
One can see that in our analysis, both the yes/no question nucleus and the focus nucleus are tonally L* H L, but they differ in their boundary alignments: the yes/no question nucleus is L* H_I L_I, so that the H is placed near the end of the I-phrase. The focus contour is L* H_P L_I, so that the H is placed near the right edge of the focused constituent.[3]

Our claim that H_P is a focus marker is supported by minimal pairs. Our first example is the pair of *Wh*-questions in (20) and (21). In Bengali, *Wh*-phrases are normally focused (cf. Culicover and Rochemont 1983, p. 140) and the *Wh*-word (here *kon* 'which') receives the nuclear stress.

(20) tumi kón mač^{h}er-mat^{h}a ranna-korle?
you which fishhead cooked
Which fishhead did you cook?

Structure:



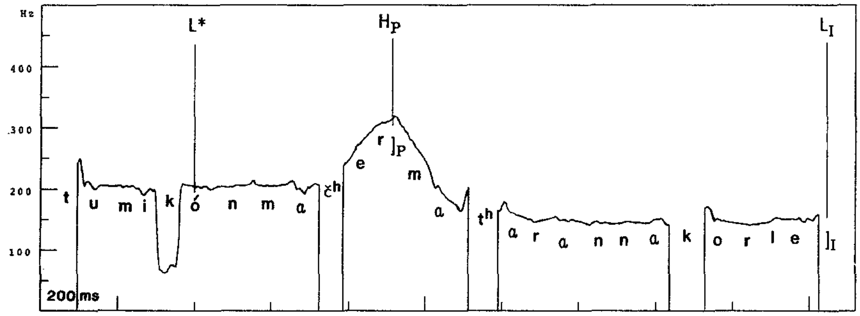


[3] Two *NLLT* reviewers ask if the yes/no question nucleus might be reanalyzed as L* H_P L_I, with the stipulation that the verb must be phrased together with its object whenever the sentence is a yes/no question. This seems unlikely to us. First, we know of no other cases in which phonological phrasing is sensitive to the distinction between questions and statements. More important, the proposal is falsified by facts of segmental phonology, as we will show in Section 9.

(21) tumi kón mač^{h}e-r mat^{h}a ranna-korle?
you which fish-'s head cooked
[Which fish's] head did you cook?

Structure

```
        x
        x                                  x
        x    x        x                    x     x
        x    x x      x x                  x   x x x
[ . . . [ kón mačʰer ]P [ matʰa ]P  [ ranna-korle ]P ]I
        |            |                              |
        L*           HP                             LI
```



The location of the pitch peak in these two utterances is predicted by our claim that H_P is a boundary tone for the focused constituent. This is *kon mač^{h}er-mat^{h}a* 'which fishhead' in (20), and *kon mač^{h}er* 'which fish's' in (21). The location of the pitch valleys is determined by our phrasal stress rules: by (13a), the strongest P-phrase in each utterance is the one containing the focused constituent (*kon mač^{h}er-mat^{h}a* or *kon mač^{h}er*); and by (12) the strongest word of the strongest P-phrase in each case is the leftmost non-clitic word, *kon*. Following principle (10), it is this syllable which attracts the L*.

4.3. *The Focus Nucleus on More Complex Texts*

To illustrate the focus contour more thoroughly, we will go through some of the possibilities for aligning it with the sentence in (22).

(22) aǰ ami raǰa-r č^{h}obi-r ǰonno ṭaka anlam
today I king's pictures-gen. for money brought
Today I brought money for the king's pictures

The following list shows the cases in which all or part of the phrase *raǰa-r č^{h}obi-r ǰonno ṭaka* 'money for the king's pictures' is focused. In the diagrams, we show P-phrase bracketings only for the focused constituent. The pitch tracings we have obtained for these utterances look much like (20) and (21), with a valley on L*, a peak on H_P, and a fall at the end.

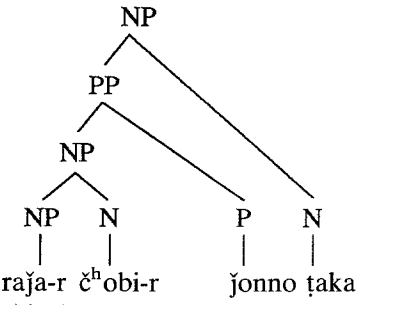
(23)

	Focused Constituent
a. [aǰ ami [raǰa-r č^{h}obi-r ǰonno ṭaka]$_P$ anlam]$_I$ L* H_P L_I	'money for the king's pictures'
b. [aǰ ami [raǰa-r č^{h}obi-r ǰonno]$_P$ ṭaka anlam]$_I$ L* H_P L_I	'for the king's pictures'
c. [aǰ ami [raǰa-r č^{h}obi-r]$_P$ ǰonno ṭaka anlam]$_I$ L* H_P L_I	'the king's pictures'
d. [aǰ ami [raǰa-r]$_P$ č^{h}obi-r ǰonno ṭaka anlam]$_I$ L* H_P L_I	'the king's'
e. [aǰ ami raǰa-r [č^{h}obi-r]$_p$ ǰonno ṭaka anlam]$_I$ L* H_P L_I	'pictures'
f. [aǰ ami raǰa-r č^{h}obi-r [ǰonno]$_P$ ṭaka anlam]$_I$ L* H_P L_I	'for'
g. [aǰ ami raǰa-r č^{h}obi-r ǰonno [ṭaka]$_P$ anlam]$_I$ L* H_P L_I	'money'

It can be seen that the L* H_P sequence always "outlines" the focused constituent.

Sentence (22) is actually ambiguous, since the phrase *raǰa-r č^{h}obi-r ǰonno ṭaka* 'money for the king's pictures' can also mean 'the king's money for pictures'. The two readings have roughly the following structures:

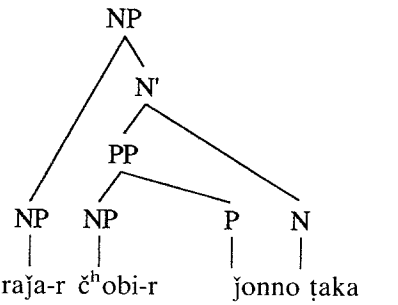
(24)a.



king's pictures-gen. for money

money for the king's pictures

b.



king's pictures-gen. for money

the king's money for pictures

The ambiguity adds even more intonational possibilities for sentence (22). For example, if the L* H_P sequence outlines the words *č^hobi-r ǰonno ṭaka*, we get the reading 'I brought the king's *money for pictures*'. Note that with this intonation, the sentence is unambiguous. Under the reading (24a), the sequence *č^hobi-r ǰonno ṭaka* doesn't form a constituent; and only constituents may be focused and thus receive the L* H_P contour. For this reason, only (24b) yields a possible interpretation under this alignment. We refrain from listing the remaining possibilities for intonating (24b), which are what one would expect.

Note finally that if we try to align L* H_P with a sequence that isn't a constituent under either reading, the result is ill-formed. Note that *ǰonno* 'for' is a postposition.

(25) *[aǰ ami raǰa-r č^hobi-r [ǰonno ṭaka]$_P$ anlam]$_I$

L* H_P L_I

today I king's pictures-gen. for money brought

To summarize, we believe the evidence is fairly conclusive that the L* H_P sequence in Bengali outlines focused constituents. We argue below that focused constituents in Bengali attract P-phrase breaks; hence our treatment of H_P as a P-phrase boundary tone.

4.4. *H_P in Final Position*

Although final P-phrases in Bengali attract the default nuclear stress, they can also receive nuclear stress by virtue of being focused. An example

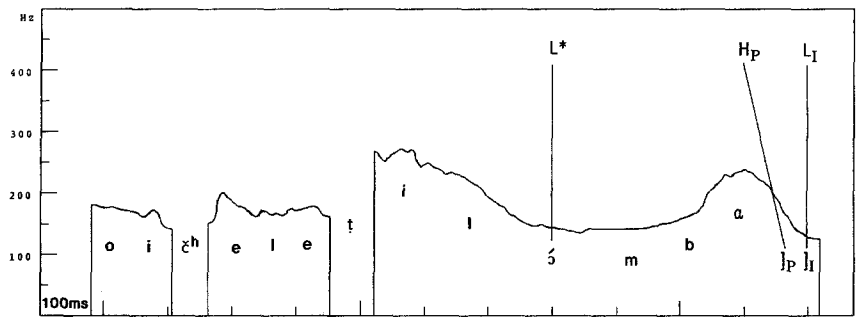
here is (26), which has a focused predicate:

(26) [oi čʰele-ṭi [lɔ́mba]$_P$]$_I$

L* H_P L_I

that boy-def. tall

That boy is *tall.* (focus nucleus)



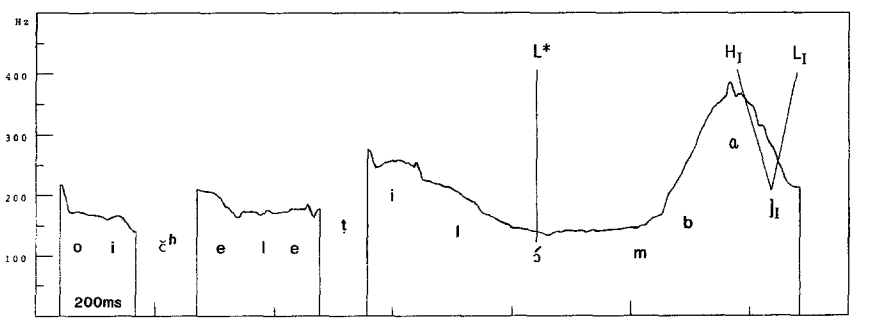
Since the focused constituent *lɔmba* is final, the pitch curve for the focus nucleus has much the same shape as a yes/no question, as in (27):

(27) [oi čʰele-ṭi [lɔ́mba]$_P$]$_I$

L* H_I L_I

that boy-def. tall

Is that boy tall? (yes/no question nucleus)



In both cases, we have L* on the main stress. Both have a HL sequence aligned with the right edge of the utterance, and thus phonetically realized

as a rapid pitch excursion on the final syllable. Note that both HL sequences are, strictly speaking, I-phrase final; brackets only mark edges and do not have phonological duration.

Despite the similar shapes of these curves, Bengali does manage to maintain a distinction between them: in all contexts, H_I normally receives a higher pitch than H_P, all else being equal. Thus the pitch peak in (27) is higher than that in (26). We have measured many other examples of H_I and H_P, in utterances with both broad and narrow overall pitch range. In our measurements, H_I ranges from 330–500 hz. while H_P ranges from 200–420 hz. Subjectively, we judge that when overall emphasis is kept constant, H_I receives a higher pitch than H_P.

A complicating factor is that questions in Bengali tend to be pronounced with a greater overall pitch range than statements. But if we control for this, comparing only *Wh*-questions ($L^* H_P L_I$) with yes/no questions ($L^* H_I L_I$), a substantial difference still remains. Examples (26) and (27) involve a large pitch difference (240 vs. 365 hz.), since in order to obtain a minimal pair, we had to compare a statement with a question.

The difference in pitch between H_I and H_P does not argue that they are phonologically distinct tone levels. These tones occur in different environments (linked to $]_I$ vs. linked to $]_P$), and therefore do not contrast phonologically. It is true that H_I and H_P differ *diacritically*, in terms of an underlying marker that indicates what boundary they associate with. But the phonetic pitch rules need not refer to this diacritic, but only to the surface context of the H. Below (Section 6), we present an argument that H_I and H_P should indeed be classified as phonologically the same tone.

To conclude this section: we have argued that Bengali has two contrasting nuclei, $L^* H_I L_I$ and $L^* H_P L_I$. The nuclei differ in how the H tone is linked (right edge of the I-phrase vs. right edge of the focused P-phrase); and in their phonetic pitch targets. When focus occurs in final position, the two contours usually differ phonetically only in the height of the H tone.

Before we proceed further, one caveat is needed. Although the generalization that H_P links to the right edge of the focused P-phrase seems secure to us, we must note that phonetically, there is some variation: the phonetic location of the H_P peak often occurs one or two syllables before, and occasionally a syllable or two after the $]_P$ boundary to which H_P is linked phonologically. Similar variation in the placement of H_P has been noticed for Swedish by Bruce (1977). Where differences of focus are to be made precise, the alignment of H_P can be controlled carefully to do this. But in less guarded speech, there is variation.

5. The Nuclei of Bengali

Our account of the L* H_I L_I and L* H_P L_I nuclei provides a framework for classifying the nuclei of Bengali in general. We have located four structural positions in which L can in principle contrast with H: the nuclear accent T*, a boundary tone linked to $]_P$, and up to two boundary tones linked to $]_I$. In this section, we go through the various ways in which these structural positions may be filled in the various Bengali nuclei.

5.1. *The "Offering" Nucleus*

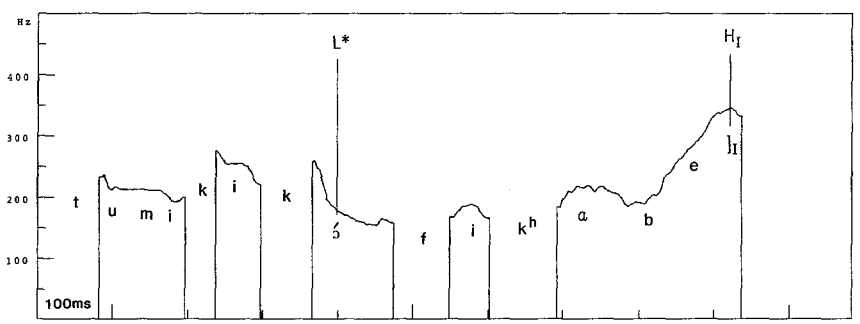
This contour naturally arises in polite offerings, as in (28).

(28) [tumi-ki kɔ́fi k^{h}abe?]$_I$

L* H_I

you Q-part. coffee drink

Would you like some coffee?



Occasionally, we have noticed this contour used as a way of asking a question tentatively, as a somewhat hesitant vocative, and as a declarative contour with a continuation rise. The shape of the offering nucleus involves a low pitch on the nuclear syllable, followed by a stretch of level or slowly rising pitch, followed by an accelerated rise around the final syllable of the I-phrase. We phonemicize this nucleus as L* H_I.

5.2. *The Declarative Nucleus*

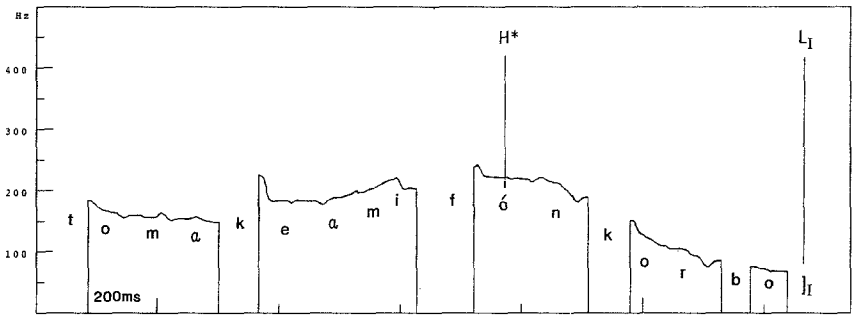
Declarative intonation in Bengali is used when there is no intent of placing focus on any particular constituent. Phonologically, it takes the form H* L_I. That is, a pitch peak occurs on the main stressed syllable, and pitch falls fairly gradually to a low at the end of the I-phrase.

(29) [[tomake ami]$_P$ [fón-korbo]$_P$]$_I$

H* L_I

you-obj. I will-call

I will call you.



Across tokens, the H* peak can take on a large range of values, depending on the pitch range of the utterance as a whole. In completely unemphatic contexts, the H* can be scaled so low that there is only a small pitch drop, and the ear has difficulty discerning pitch or stress distinctions.

A peculiarity of declarative intonation is that it can be used only under neutral stress placement, with main prominence given to the rightmost P-phrase in the I-phrase. The reason, we think, is this: the only way a sentence could have stress on a non-final constituent would be for it to have focus on a non-final P-phrase, because otherwise the I-phrase Stress Rule (13b) assigns stress to the rightmost P-phrase. But when a constituent is focused, Bengali requires use of the focus nucleus, L* H_P L_I. Thus the declarative nucleus is pre-empted in all positions but final.

The restriction of declarative intonation to final position has two implications. First, it raises a problem for the claim that there is no such thing as neutral, unmarked phrasal stress (Bolinger 1972). For Bengali declaratives, any use of narrow focus is obligatorily marked by use of the focus nucleus L* H_P L_I. The fact that the non-focus nucleus H* L_I occurs only on final P-phrases indicates that when narrow focus is not present, there is only one possible stressing, namely the phonologically assigned one. The Bengali evidence thus suggests that the traditional distinction between focus stress and phonologically assigned stress is a real one.

A negative result of the restriction of declarative intonation to final position is that the detailed tonal structure of the declarative nucleus is hard to determine. For instance, instead of H* L_I, we might posit the sequence H* L_P L_I, which is the structure motivated by Pierrehumbert

(1980) for English. Such a tonal sequence would link to the text of (29) as in (30):

(30) [[tomake ami]$_P$[fón-korbo]$_P$]$_L$

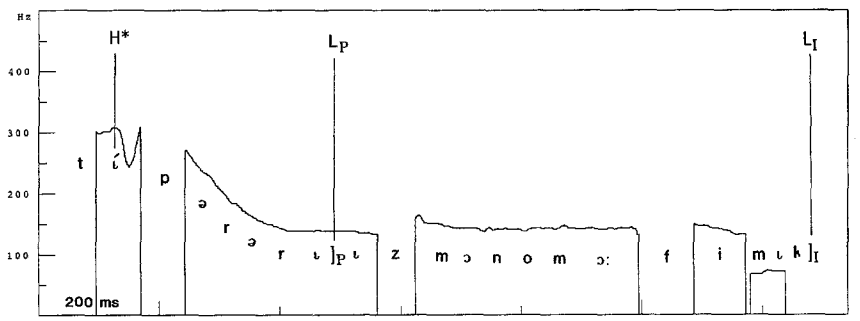
H* L_P L_I

But nothing in our phonetic measurements would enable us to decide between the representations of (29) and (30); certainly we have found no evidence that the two contrast with each other.

In English, the possibilities for diagnosis are different, because declarative intonation may occur on a focused, non-final word. In such cases, evidence for the structure H* L_P L_I emerges: the pitch fall levels off near the end of the main stressed word. This is shown in (31), in which this pitch corner appears near the end of the main stressed word *Tipperary*.

(31) [[Típperary]$_P$ [is monomorphemic]$_P$]$_I$

H* L_P L_I



This is Pierrehumbert's (1980, section 2.4) argument for representing the English declarative nucleus as H* L_P L_I; the alternative of H* L_I could not describe the systematic behavior of the "corner" in the fall.

Since structures like (31) are not available in Bengali, we cannot test for the presence of L_P. For reasons to be made clear later on, we select H* L_I as our representation for the Bengali declarative nucleus.

5.3. *Declarative Nucleus with Continuation Rise*

This nucleus is used to make statements with the implication that something else is to follow; it also occurs in other contexts that are harder to define. Phonetically, it resembles the declarative nucleus, except that pitch

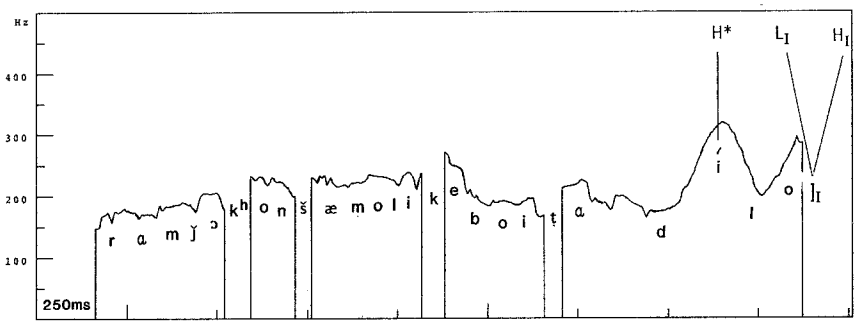
rises at the very end. The pitch level reached by the rise is usually not great. We phonemicize this contour as H* L_I H_I, as in (32).

(32) [ram ǰɔk^{h}on šæmoli-ke boi-ṭa dílo]$_I$ . . .

H* L_I H_I

Ram when Shamoli-obj. book-def. gave

When Ram gave the book to Shamoli, . . . (continues)



Like the declarative nucleus, the declarative with continuation rise is limited to contexts of neutral phrasal stress. For this reason, we cannot exclude the analysis H* L_P L_I H_I on the basis of the data, though below we give theoretical grounds for ruling it out.

5.4. *Focus Nucleus with Continuation Rise*

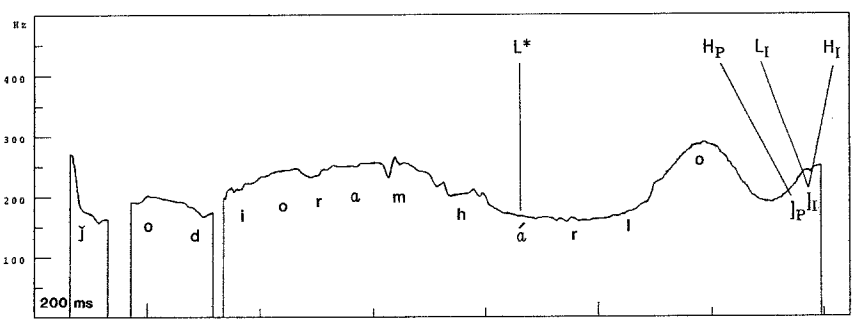
Like the declarative contour, the focus contour has a continuation rise variant, which occurs in (33) on the word *harlo*.

(33) [ǰodio ram [hárlo,]$_P$]$_I$ (o k^{h}ub b^{h}alo k^{h}eleč^{h}ilo)

L* H_P L_I H_I

Although Ram lost, (*he very well played*)

Although Ram *lost*, he played very well.

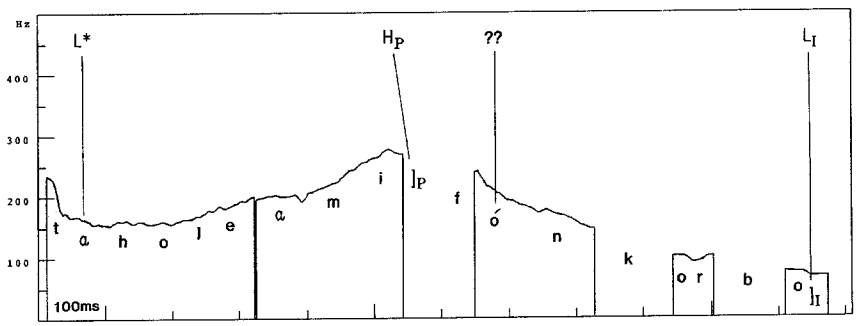


In our data, the focus with continuation rise appears much like the focus nucleus, except that a moderate rise appears on the final syllable. We phonemicize it as L* H_P L_I H_I. Note that this nucleus supports our claim that two boundary tones may link to the I-phrase boundary in Bengali: it has just the same tones as the ordinary focus nucleus (L* H_P L_I), plus the H of the continuation rise. The latter tone would have no structural position available if we didn't allow it to share the I-phrase boundary with L_I.

5.5. *The Downstep Nucleus*

An example of the downstep nucleus appears in (34).

(34) (ǰodi tumi na ašo,) tahole ami fón-korbo
if you not come then I will-call
If you don't come, then I'll call.



Here, the main stress is on the clause-final verb, *fón-korbo*. The sequence *tahole ami* receives a rising head, which we phonemicize as L* H_P. The main stressed syllable, *fón*, sounds distinctly lower than the preceding syllable, but itself begins a pitch fall that continues to the end of the sentence. The effect is that of downstep, as in many tone languages and the English contours discussed by Pierrehumbert (1980). Semantically, downstep seems to indicate some kind of finality.

The analysis of downstep is controversial. Goldsmith (1976) and Ladd (1983) suggest that downstep is a feature, included in the tonal feature matrix of a H tone, that induces a lower pitch on the H and all later highs in the phrase. Others, for example Clements and Ford (1979), propose a more abstract analysis, based on the following reasoning. L tone frequently lowers the pitch of a following H in H L H sequences. Moreover,

H + downstepped H sequences are often related phonologically to H L H. This suggests that downstep is the result of floating L tone, which has no phonetic realization itself, but has phonetic effects in triggering a lowering of the pitch target for H tones to its right.

Bengali is not the language that will resolve this issue. The downstepped nucleus is not particularly common, and cases of iterative downstep, going across a whole series of pitch accents, appear to be missing. Thus our analysis is somewhat arbitrary, based on our general theoretical preference for the floating L account. Our proposal for Bengali is that downstepped H* takes the form of a bitonal pitch accent, L + H*. The H* tone is aligned with the nuclear stress. The L is essentially inert, having no phonetic target value; its only function is to trigger a phonetic rule lowering the pitch of the following H*. Our analysis imitates Pierrehumbert's (1980) analysis of the H* + L pitch accent of English, in which the L serves only to downstep a following H.

Under this view, the downstep nucleus takes the form L + H* L_I. Like the declarative nucleus, the downstep nucleus appears to be limited to cases of unmarked phrasal stress; it cannot appear on non-final P-phrases because all such cases involve focus.

5.6. *Downstep Nucleus with Continuation Rise*

Not surprisingly, the downstep nucleus has a variant with a continuation rise, phonemicized L + H* L_I H_I. This variant is rare, because of a semantic contradiction: downstep suggests finality, but a continuation rise suggests that more is to come. A context that is final on a small scale, but non-final on a large scale, permits downstep with continuation rise, as in (35).

(35) (ǰodi tumi na ašo,) [[tahole ami]$_P$ [fón-korbo;]$_P$]$_I$

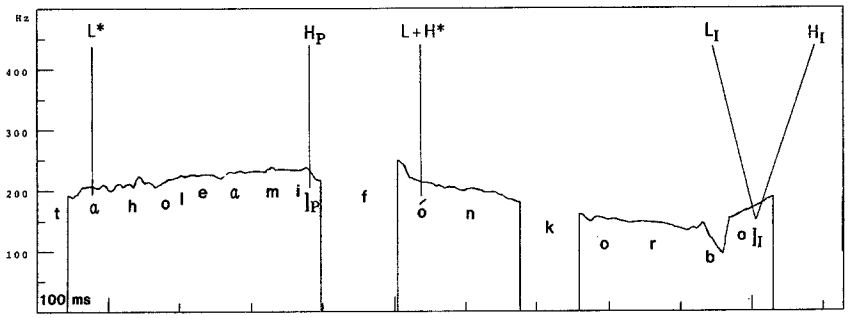
L* H_P L + H* L_P H_I

If you not come then I will-call

(ar ǰodi tumi ašo, tahole lik^{h}bo.)

and if you come then I-will-write

If you don't come, then I'll call; and if you do come, then I'll write.



The crucial nucleus here is *fón-korbo* 'call': it is final with respect to the first clause, and thus merits a downstep, but it is continued by the next two clauses, and thus merits a continuation rise.

6. The Structure of the Nuclear Inventory

The account just given essentially completes the inventory of nuclei we have found in Bengali. Other nuclei are found in vocatives, but they repeat the tone sequences already described, and are distinguished instead by their durational properties; they do not materially effect the points to be made here. In this section we ask to what extent the Bengali nuclear inventory is the result of general principles rather than being just an arbitrary list.

If we combine the three pitch accents H*, L* and L + H* with the various boundary tone sequences (optional T_P, optional T_I, obligatory T_I), we get a total of 54 logically possible nuclei. Of these, eight actually exist:

(36)a.	L* H_I	Offering (5.1)
b.	L* H_I L_I	Yes/no question (4.1)
c.	L* H_P L_I	Focus (4.2)
d.	L* H_P L_I H_I	Focus with continuation rise (5.4)
e.	H* L_I	Declarative (5.2)
f.	H* L_I H_I	Declarative with continuation rise (5.3)
g.	L + H* L_I	Downstep (5.5)
h.	L + H* L_I H_I	Downstep with continuation rise (5.6)

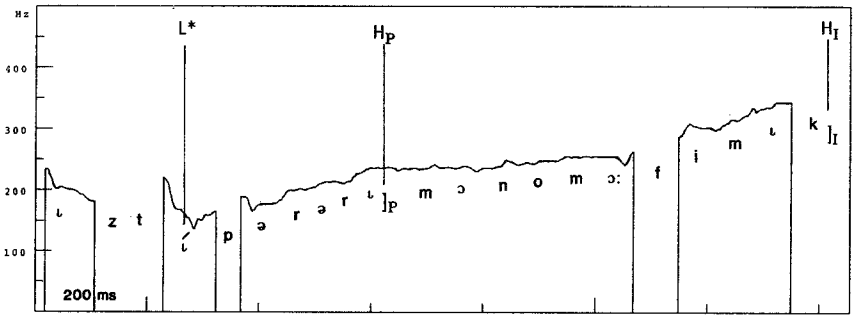
The existing sequences share an obvious formal property: identical tones do not occur in sequence. We claim that this gap is significant, and that Bengali is an example of an intonation language that obeys the Obligatory Contour Principle (OCP; Leben 1973, McCarthy 1986), which prohibits precisely such sequences.

Our claim must be defended against a plausible objection: could the fact that all the tunes obey the OCP be just an artifact of our analysis? That is, if we set up phonological tones only in those places where the pitch contour changes direction, the OCP would be obeyed by default. In fact, it can be shown that the effects of the OCP in Bengali are not at all vacuous.

Consider first what we might expect as the phonetic result of /L* H_P H_I/. Such a contour would begin with L* on the main stress, then rise to H_P near the end of the focused constituent. What would happen next depends on the phonetic pitch rules for H_I, and we must consider two possibilities. For English, Pierrehumbert (1980) argues that H_I after H_P undergoes an "upstep" rule, which gives it a higher pitch value than the preceding H_P. On long nuclei this produces the "double rise" question intonation illustrated in (37):

(37) Is Típperary $]_P$ monomorphemic? $]_I$

L* H_P H_I



Such *rise + flat + rise* sequences do not occur as Bengali nuclei.

Suppose on the other hand that Bengali has no upstep rule, and that H_I is given the same phonetic target as the preceding H_P. This would produce a contour that rises up to the end of the focused constituent, then stays level to the end of the I-phrase. This, too, is excluded in Bengali.

The OCP also rules out any nucleus in which all tones are the same: L* (L_P) (L_I) L_I and H* (H_P) (H_I) H_I. Such nuclei would be expected to form long level sequences, which are phonologically unattested.

Other contours are ruled out in Bengali by the OCP as well. These include the following:

(38)a.	$L^* H_P H_I L_I$	(L on main stress, rise to end of focused word, level H until last syllable, then rapid fall)
b.	$H^* (H_P) H_I L_I$	(H on main stress, level to last syllable, then rapid fall)
c.	$H^* H_P L_I$	(H on main stress, level to end of focused word, then gradual fall to last syllable)
d.	$H^* H_P L_I H_I$	(all H, except downward scoop between end of focused word and last syllable)

We conclude that the OCP does not hold for Bengali simply as an artifact; rather, we are making an empirical claim, with which our data are consistent.

There is another role that the OCP plays in our analysis: it allows us to make a principled decision in cases where more than one representation could depict the same contour. For example, we noted above that the declarative contour $H^* L_I$ could also be represented as $H^* L_P L_I$. Because this nucleus appears only in final position, the "corner" effects by which we could detect the L_P are not available. Given the evidence for the OCP elsewhere in the system, we adopt the representation $H^* L_I$.

The difference between English and Bengali argues in favor of Odden's (1986, 1988) claim that the OCP is not universal, but varies in its effects across languages. We note that even in English there may be OCP effects at a different level: Beckman and Pierrehumbert (1986) suggest that Pierrehumbert's (1980) H* + H pitch accent can be eliminated from the inventory of bitonal accents, leaving only H*, L*, H* + L, H + L*, L* + H, and L + H*. Under this analysis, English obeys the OCP at the level of the pitch accent. Bengali can thus be viewed as an extreme case in which the OCP is obeyed at the level of the entire tune.

If Bengali obeys the OCP, we have an argument for a claim made earlier: that H*, H_P, and H_I really are instances of the same tone, namely H, even though they differ in where they link and in their phonetic pitch levels. If we phonemicized them as distinct tones, we could not use the OCP to account for the limits on their distribution.

The set of Bengali nuclei can be looked at in another way: given the OCP, which of the logically possible tunes actually exist? With the OCP, the system we have described allows for only twelve possibilities. Of these, eight occur (cf. (36)), but the following four do not:

(39)a. $H^* L_P H_I$
b. $H^* L_P H_I L_I$
c. $L + H^* L_P H_I$
d. $L + H^* L_P H_I L_I$

We exclude these by stipulating that L_P does not occur. In this respect Bengali resembles Swedish (Bruce 1977), which also lacks L_P.

To conclude, we propose the following account of the Bengali nuclei: the structural positions of the nucleus are T* (T_P) (T_I) T_I; pitch accents are L*, H*, and L + H*; there is no L_P; and all contours must obey the OCP. These assumptions generate all and only the eight observed nuclei.

7. Intonational Derivations

In this section we will argue, following Gussenhoven (1984), that intonational phonology may involve underlying forms and derivations. Our argument is based on an effort to decompose the nuclear contours into morphemes. Although nuclei are identifiable as "tunes", semantically they are best treated as being formed by affixation within the intonational lexicon. At present, any such treatment is tentative, since our understanding of the meanings and uses of the contours is limited.

An obvious case where nuclei can be broken down is the continuation rise morpheme, which can be analyzed as either H_I or $L_I H_I$, depending on how one slices the contours. The continuation rise can be added to any of the three declarative sequences (H*, L + H*, L* H_P), and adds what is intuitively the same meaning in each case.

A more interesting case of decomposition (suggested to us by Carlos Gussenhoven) requires us to posit some intonational phonology. Our analysis is based on two asymmetries between the phonology of statements and questions.

(a) Contrast: In statements, the Bengali intonational system marks a distinction between narrow and neutral focus: narrow focus is conveyed using L* H_P L_I (H_I), while neutral focus is marked with H* L_I(H_I) or L + H* L_I (H_I). But in questions, focus is not marked intonationally: the same contours, L* H_I and L* H_I L_I, are used for both neutral and narrow focus (see, for example, (16) and (27)).

(b) Distribution: In statements, the neutral-focus nuclei H* L_I (H_I) and L + H* L_I (H_I) may occur only on the last P-phrase of the sentence, while the narrow focus nuclei L* H_P L_I and L* H_P L_I H_I may occur anywhere. In contrast, for questions there is no limitation on the distribution of the nuclei L* H_I and L* H_I L_I.

A pleasing explanation for these asymmetries would be to posit that in *any* sentence, including questions, it is possible to have an underlying morpheme of the form /L* H_P/, whose function is to mark narrow focus. In declaratives, this underlying morpheme survives on the surface, giving rise to L* H_P L_I (H_I). In offering questions and yes/no questions, however,

the I-phrase boundary tones are H_I and $H_I L_I$, respectively. Adding these to the focus morpheme $L^* H_P$, we would derive sequences that violate the OCP, namely $L^* H_P H_I$ and $L^* H_P H_I L_I$.

At this point we can invoke Yip's (1988) suggestion that the OCP often "triggers" phonological rules that repair violations of it. Applying this idea to Bengali, we posit the following repair rule:

(40) *H_P Deletion*
$H_P \rightarrow \emptyset / \_\ H$

H_P Deletion neutralizes the distinction between $L^* H_P$ and L^* before H_I. As a result, the surface nuclei $L^* H_I$ and $L^* H_I L_I$ are often ambiguous between neutral and focused readings. The following derivations illustrate this; /+/ marks morpheme boundary.

(41)a. *Offering Question, Neutral Focus Accent*
$L^* + H_I$

b. *Offering Question, Narrow Focus Accent*
$/L^* H_P + H_I / \rightarrow L^* + H_I$

c. *Yes/No Question, Neutral Focus Accent*
$L^* + H_I L_I$

d. *Yes/No Question, Narrow Focus Accent*
$/L^* H_P + H_I L_I / \rightarrow L^* + H_I L_I$

With this analysis, we can explain the two asymmetries just noted. (a) Contrast: the neutral vs. narrow focus contrast is marked only in statements, because in questions H_P Deletion eliminates the contrast on the surface. (b) Distribution: we argued earlier that the neutral-focus statement nuclei are limited to final position because this is the phonologically-assigned location for nuclear stress – if nuclear stress is overridden by narrow focus, then a narrow-focus contour ($L^* H_P$) is required. The question accent L^* is not subject to this limitation, because it is the surface form for both underlying /L*/ (neutral focus) and underlying $/L^* H_P/$ (narrow focus). Since the latter is not restricted in its distribution, surface L^* may occur anywhere.

H_P Deletion could apply as a rule of phrasal phonology, following tune-text association. Alternatively, we could place it in the lexical phonology, applying within the lexicon of intonational tunes. We know of no data that bear on this question.

The H_P Deletion analysis supports Gussenhoven's (1984) view that intonational tunes, just like segmental morphemes, may undergo phono-

logical rules. In the present case, the rules actually neutralize an underlying distinction.

Using the H_P Deletion analysis, we can factor the lexicon of Bengali nuclei into morphemes as follows:

(42)a. *Accents* ("stems")

L*	question accent
H*	declarative accent
L* H_P	focus accent

b. *Boundary Tones* ("suffixes")

L_I	neutral
$L_I H_I$	continuation rise
H_I	offering
$H_I L_I$	yes/no

c. *Prefix*

L+	finality marker (forms L + H* when attached to H*)

These morphemes combine fairly freely, subject to this proviso: a contour that violates the OCP is not allowed unless H_P Deletion "rescues" it. That is, the OCP acts as a surface filter on the inventory of tunes. We believe that further decomposition of the contours, especially the boundary tone sequences, may be possible, but to do this will require a better understanding of their meanings.

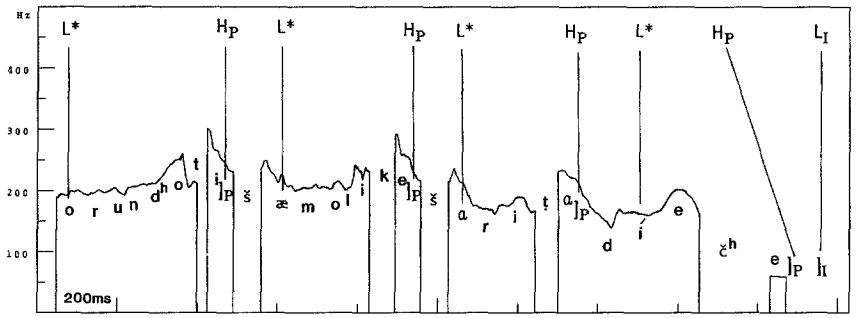
8. The Head

In Bengali intonation, heads have a considerably simpler structure than nuclei. In this section, we first discuss the possibilities for the phonological representation of heads, then mention an additional head that arises from rules of phonetic interpolation.

8.1. *Phonological Heads: L* H_P*

The great majority of heads we have observed can be described as a sequence of one or more rises. A clear example of this appears in (16), where the head is *tumi-ki*. Where the head contains several P-phrases, each one receives its own rise. This occurs, for instance, in (43), with rises on *orund^{h}oti*, *šæmoli-ke*, and *šari-ṭa*.

(43) orund^{h}oti šæmoli-ke šari-ṭa *díeč^{h}e*
Arundhati Shamoli-obj. sari-def. gave
Arundhati *gave* the sari to Shamoli.



We posit that phonologically, the head is generated by assigning a L* H$_P$ sequence to each prenuclear phonological phrase. For (43), three such sequences are assigned, as shown in (44):

(44) [[orund^{h}oti]$_P$ [šæmoli-ke]$_P$ [šari-ṭa]$_P$ [díeč^{h}e]$_P$]$_I$
L* H$_P$ L* H$_P$ L* H$_P$ H$_P$L$_I$

If the nuclear tone is H*, as in (32), then the OCP is violated underlyingly. H$_P$ Deletion (40) then applies to resolve the violation, as follows:

(45)a.
[[ram ǰɔk^{h}on]$_P$ [šæmoli-ke]$_P$ [boi-ṭa]$_P$ [dílo]$_P$]$_I$ input
L* H$_P$ L* H$_P$ L* H$_P$ H* L$_I$ H$_I$
Ram when Shamoli-obj. book-def. gave

When Ram gave the book to Shamoli, . . . (continues)

b.
[[ram ǰɔk^{h}on]$_P$ [šæmoli-ke]$_P$ [boi-ṭa]$_P$ [dílo]$_P$]$_I$ H$_P$ Deletion
L* H$_P$ L* H$_P$ L* H* L$_I$ H$_I$

Whether or not this occurs, a smooth, slightly sagging interpolation is made between the L* and the following H.

What other heads are found phonologically in Bengali? Our conjecture is: none. It is true that one sometimes finds sequences that look fairly level, as in (20) (*tumi*), (21) (*tumi*), and perhaps in (32) (*šæmoli-ke*).

However, most such cases are quite short, as in the first two examples just cited. Further, all cases that look like they might be level heads are pronounced quite unemphatically; indeed, most are function words like *tumi*. Moreover, in many examples where we have found level heads, we have inspected tracings of repetitions of the same utterance and have found a slight rise. In these cases, the level sequence and the slight rise seem perceptually very much alike. For these reasons we think that phonologically, even heads that don't rise much are best treated as degenerate cases of L* H_P. The lack of a rise should be attributed to the rules of phonetic interpretation, which assign almost identical pitch targets to L* and H_P in such contexts.

To support this claim, we note the following observations. (a) Even in the nucleus, the pitch contour under low emphasis can be phonetically rather flat. (b) In general, heads, which are weakly stressed, have smaller pitch excursions than the main-stressed nuclei (cf. (43)). The same has been observed for Swedish by Bruce (1977). (c) For L* H_p in nuclear position, we have often observed that the pitch difference between the two tones is small when they are close together in time. Combining these factors, we would expect that heads which were particularly short or unemphatic could have virtually no rise at all.

8.2. *The Rise-Fall Head*

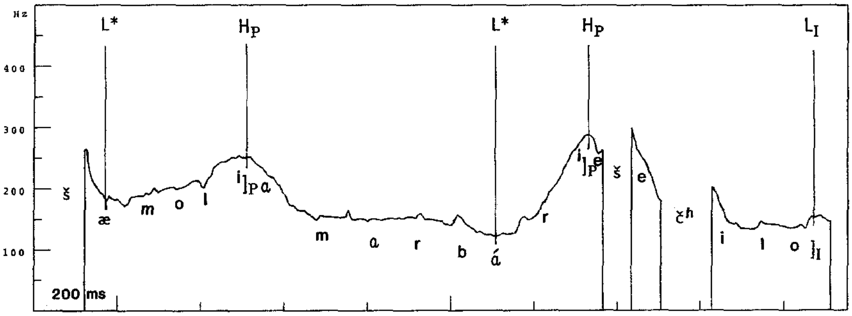
In this section we discuss an additional head, which involves a pitch rise followed by a fall. This head need not be represented by any additional underlying tonal configurations, but arises instead from processes of phonetic interpolation.

The rise-fall head is found when the strongest stress in a P-phrase is not initial in the P-phrase. This can happen when the P-phrase begins with a clitic-like function word such as a pronoun. According to the P-phrase Stress Rule (12), the strongest stress of such a P-phrase will fall not on the clitic, but on the leftmost nonclitic word. An example of this is (46), where the unstressed clitic is *amar* 'my', and the P-phrase *amar bari* 'my house' is focused and receives main stress.

(46)

```
                      x
       x              x     x
       x  x x   x x   x x   x x  x x
   [ [ šæmoli ]P [ amar bari ]P [ ešečʰilo ]P ]I
       |     |        |  |              |
       L*    HP       L* HP             LI
     Shamoli   my    house  had-come-to
```

Shamoli had come to *my house*.

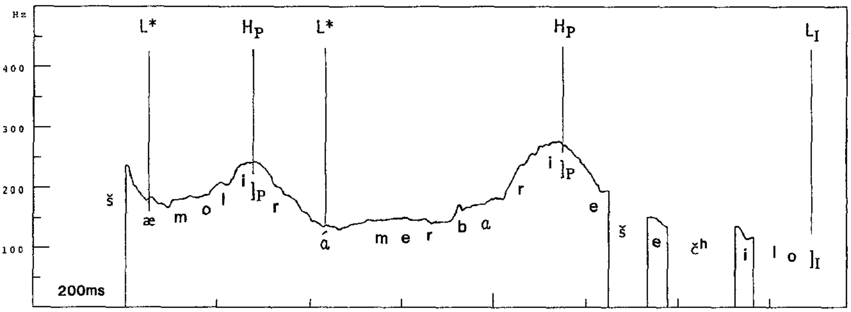


In the pitch tracing, the peak for the H_P at the end of *šæmoli* can be seen, followed by a fall down to the valley on the main stressed syllable *ba*. The head (defined above as everything preceding the main stress) thus has a rise-fall shape. It should be clear, however, that cases like (46) do not require an expansion in the phonological inventory of heads: the pitch contour simply results from phonetic interpolation between tones whose existence and location have already been justified.

Example (46) should be compared with (47), where the focused constituent is *ram-er bari* 'Ram's house'. Unlike *amar* 'my', *ram-er* is not a clitic; it therefore receives the strongest stress in the P-phrase by rule (12), and thus attracts the pitch valley of L*.

```
(47)                  x
         x            x     x     x
         x  x x       x  x  x x   x x  xx
       [ [ šæmoli ]P [ rám-er bari ]P [ ešečʰilo ]P ]I
           |      |   |         |               |
           L*     HP  L*        HP              LI
           Shamoli    Ram's house    had-come-to
```

Shamoli had come to *Ram's house*



The distinction between cases like (46) and (47) justifies the formulation of the P-phrase stress rule (12): the rule skips over initial clitic words like *amar*, but not full words like *ram-er*, so that tune-text alignment comes out differently in the two cases.

8.3. *Bengali Tune Structure*

This concludes our account of Bengali nuclei and heads. To sum up, the overall structure of the tune in Bengali can be characterized with the formula $(T^* \ T_P)_0 \ T^* \ (T_P) \ T_I \ (T_I)$. This can be compared to English, whose tune structure (inferred from Pierrehumbert (1980) and Beckman and Pierrehumbert (1986)) is $(T_I) \ (T^* \ (T_P))_0 \ T^* \ T_P \ T_I$.

9. P-PHRASING IN BENGALI

We have maintained above that the constituent structure that is relevant to intonation in Bengali is phonological, not syntactic. In other words, the "boundaries" that boundary tones link to in Bengali are phonological boundaries like $]_P$ and $]_I$, not syntactic boundaries like $]_{NP}$ or $]_S$. In this section we present some support for this claim.

Our argument makes use of two segmental rules of Bengali. We show first that exactly the same P-phrase domains that are used by the intonational system are also relevant to segmental phonology. Next, we argue that the domains are truly phonological, not syntactic. Finally, we present a tentative account of how P-phrases are derived from syntactic structure.

9.1. */r/ Assimilation*

In Bengali, the approximant /r/ can optionally assimilate totally to any following coronal consonant. This process applies in underived monomorphemic words as well as across morpheme boundaries.

(48)a.	bɔrša ~ bɔššа	'rainy season'
b.	bɔrdi ~ bɔddi	'elder sister'
c.	b^horti ~ b^hotti	'full'
d.	kor-$č^h$e ~ koč-$č^h$e	'do-3 pers. pres.'
e.	kor-lo ~ kol-lo	'do-3 pers. fut.'

/r/ Assimilation can also apply across word boundaries, provided that the relevant words fall within the same P-phrase. For example, in sentence (23c), repeated below, the sequence *raǰa-r* $č^h$*obi-r* is focused and forms a

single P-phrase. For this reason, /r/ Assimilation may apply to the /rč^h/ sequence, yielding [čč^h]. But the /r/ of *č^{h}obi-r* is in a separate P-phrase from the /ǰ/ of *ǰonno*, so that assimilation of /r/ to /ǰ/ is blocked.

(49)

	L*		H_P		L_1
	|		|		|
[aǰ	ami [ráǰa-r	č^{h}obi-r]$_P$	ǰonno	ṭaka	anlam]$_I$
	[č č^h]	[r]	[ǰ]		
today I	*king's pictures*		*for*		*money brought*

Today I brought money for *the king's pictures*.

Exactly the reverse holds for the reading under (50), where the focused sequence *č^{h}obi-r ǰonno* forms a P-phrase to the exclusion of *raǰa-r*:

(50)

	L*		H_P		L_1
	|		|		|
[aǰ	ami [	ráǰa-r [č^{h}óbi-r	ǰonno]$_P$	ṭaka	anlam]$_I$
	[r]	[č^h]	[ǰ ǰ]		
today I	*king's*	*pictures for*			*money brought*

Today I brought the king's money *for pictures*.

We will not list the remaining versions of this sentence ((23a, b, d–g)), since /r/ assimilation works in exactly the same way: it applies only within P-phrases, where the latter can be independently determined by the positioning of L* and H_P.

9.2. *Voicing Assimation*

Another rule of Bengali phrasal phonology applies to stop sequences, optionally assimilating the first to the second in voicing. Some examples of word-internal application of this rule are as follows:

(51)a.	pat-bo ~ pad-bo	'lay down-1st p. fut.' (cf. *pat-i* 1st p. pres.)
b.	rag-tam ~ rak-tam	'be angry-1st p. habit. past' (cf. *rag-i* 1st p. pres.)
c.	map-ben ~ mab-ben	'measure-3 p. honorific fut.' (cf. *map-i* 1st p. pres.)

At the phrasal level, Voicing Assimilation is bounded within P-phrases, and the domains it diagnoses agree with the domains used by intonation. The following example illustrates this:

(52)a. L^* H_P L_I

| | |

[amader [k^hárap biman-er $]_P$ opor b^hɔe $]_I$

[b b]

we defective airplanes-obj. on fear

We are afraid of *defective airplanes.*

b. L^* H_P L_I

| | |

[amader [k^hárap $]_P$ biman-er opor b^hɔe $]_I$

[*p*] [*b*]

We are afraid of *defective* airplanes.

In (52a), where intonation shows that *k^harap bimaner* is a single P-phrase, the /p/ of *k^harap* assimilates in voicing to the /b/ of *bimaner*. If intonation shows that *k^harap* and *bimaner* are in separate P-phrases, as in (52b), then there is no voicing assimilation. Other examples pattern in the same way.[4]

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[4] By making use of segmental phonology, we can now give evidence against the proposal made by our reviewers in footnote 3. The idea was to replace our L^* H_I L_I analysis for the yes/no question nucleus with L^* H_P L_I, stipulating that in yes/no questions, everything after the main stress is incorporated into the preceding P-phrase. Were this suggestion correct, we would expect that /r/ Assimilation would be possible in (i.a) and Voicing Assimilation in (i.b):

(i)a. L^* H_P L^* H_P L_I

| | | | |

*[tumi ki $]_P$ [úpošagor dek^hle $]_P$ $]_I$

[d d]

you Q-part. bay saw

Did you see a *bay*?

b. L^* H_P L^* H_P L_I

| | | | |

*[tumi ki $]_P$ [ɔ́nek odd^hapɔk ḍakle $]_P$ $]_I$

[g ḍ]

you Q-part. many professors called

Did you call *many professors*?

In fact, these phonological rules are blocked at the relevant juncture; the correct outputs are [rd] and [kḍ] respectively. This shows that there must be a P-phrase break before the verb. Thus L^* H_P L_I is not an adequate analysis for yes/no questions, since in these sentences it would wrongly place the pitch peak in preverbal position. Our analysis, with L^* H_I L_I, correctly places the pitch peak at the end of the I-phrase.

9.3. *Variation in P-Phrasing*

To summarize so far, we have argued on the basis of two segmental rules that the domains relevant to intonation are the same domains that are relevant to phonological juncture. We next argue that these domains are true phonological phrases and not syntactic constituents. Our argument is the standard one: there are cases in which a phonological phrase corresponds to no plausible constituent of syntactic representation.

This situation arises in two related cases. First, it can occur in rapid or careless speech: as in many other languages, the domains in rapid speech get larger, so that material that would be phrased separately in deliberate speech gets phrased together in rapid speech.

This can be demonstrated for Bengali with intonation patterns, particularly within the head. For example, (43), which was pronounced rather deliberately, was phrased as in (53a). But in faster speech it could also be phrased (and intonated) as in (53b–c). In very rapid speech, (53d) is possible.

(53)a. [[orund^{h}oti]$_{P}$ [šæmoli-ke ≡ ≡šari-ṭa]$_{P}$ [díeč^{h}e]$_{P}$]$_{I}$

L* H$_{P}$ L* H$_{P}$ L* H$_{P}$ L* H$_{P}$ L$_{I}$

Arundhati *Shamoli-obj.* *sari-def.* *gave*

Arundhati *gave* the sari to Shamoli.

b. [[orund^{h}oti]$_{P}$ [šæmoli-ke šari-ṭa]$_{P}$ [díeč^{h}e]$_{P}$]$_{I}$

L* H$_{P}$ L* H$_{P}$ L* H$_{P}$ L$_{I}$

c. [[orund^{h}oti šæmoli-ke]$_{P}$ [šari-ṭa]$_{P}$ [díeč^{h}e]$_{P}$]$_{I}$

L* H$_{P}$ L* H$_{P}$ L* H$_{P}$ L$_{I}$

d. [[orund^{h}oti šæmoli-ke šari-ṭa]$_{P}$ [díeč^{h}e]$_{P}$]$_{I}$

L* H$_{P}$ L* H$_{P}$ L$_{I}$

In (54), we give a similar sequence, set up so that P-phrasing can also be diagnosed by the rule of /r/ Assimilation. The forms of (54) would all be glossed the same; (54a) is deliberate speech, (54b) and (54c) are faster, and (54d) is quite fast.

(54)a. L* H_P L* H_P L* H_P L* H_P L_I

[[ɔmor]$_P$ [čador]$_P$ [tara-ke]$_P$ [díeč^{h}e]$_P$]$_I$

[r] [č] [r] [t]

Amor *scarf* *Tara-obj.* *gave*

Amor *gave* a scarf to Tara

b. L* H_P L* H_P L* H_P L_I

[[ɔmor čador]$_P$ [tara-ke]$_P$ [díeč^{h}e]$_P$]$_I$

[č č] [r] [t]

c. L* H_P L* H_P L* H_P L_I

[[ɔmor]$_P$ [čador tara-ke]$_P$ [díeč^{h}e]$_P$]$_I$

[r] [č] [t t]

d. L* H_P L* H_P L_I

[[ɔmor čador tara-ke]$_P$ [díeč^{h}e]$_P$]$_I$

[č č] [t t]

The argument in favor of phonological domains is clear: it is extremely unlikely that rapid pronunciation would shift the *syntactic* representation of a sentence in a way that would produce the variants above. But expansion of phonological domains with more rapid speech is commonplace.

Below we give parallel facts based on Voicing Assimilation. In the example below, (55a) represents deliberate speech; (55b) and (55c) are faster, and (55d) is quite fast:

(55)a. L* H_P L* H_P L* H_P L* H_P L_I

[onup]$_P$ [bag^h]$_P$ [kaǰol-ke]$_P$ [díeč^{h}e]$_P$]$_I$

[p] [b g^h] [k]

Anup *tiger* *Kajol-obj.* *gave*

Anup gave a tiger to Kajol.

b. L* H_P L* H_P L* H_P L_I

[[onup bag^h]$_P$ [kaǰol-ke]$_P$ [díeč^{h}e]$_P$]$_I$

[b b g^h] [k]

(55)c. L* H_P L* H_P L* H_P L_I

[[onup]$_P$ [bag^h kaǰol-ke]$_P$ [díeč^{h}e]$_P$]$_I$

[p] [b k k]

d. L* H_P L* H_P L_I

[[onup bag^h kaǰol-ke]$_P$ [díeč^{h}e]$_P$]$_I$

[b b k k]

There is one other way in which larger P-phrases may arise: like English, Bengali sometimes assigns no pitch accent to prenuclear constituents that form old information in a discourse. Such "deaccented" constituents are P-phrased together with either the preceding or the following constituent. Thus in prenuclear (but not post-nuclear) position, Bengali has a one-to-one correspondence between pitch accents and P-phrases. An example of this is (56): the discourse that begins with (56a) may be continued with either (56b) or (56c).

(56)a. [[šæmoli]$_P$ [čador]$_P$ [ram-ke]$_P$ [dieč^{h}e]$_P$]$_I$ . . .

L* H_P L* H_P L* H_P L_I H_I

Shamoli scarf Ram-obj. gave

b. L* H_P L* H_P L_I

. . . [[ar ɔmor čador]$_P$ [tara-ke]$_P$ [dieč^{h}e]$_P$]$_I$

[č č] [r] [t]

and Amor scarf Tara-obj. gave

c. L* H_P L* H_P L_I

. . . [[ar ɔmor]$_P$ [čador tara-ke]$_P$ [dieč^{h}e]$_P$]$_I$

[r] [č] [*t t*]

Shamoli gave a scarf to Ram, and Amor gave a scarf to Tara

The deaccented constituent in these forms is the repeated item *čador*, which phrases leftward in (56b) and rightward in (56c). Its pitch contour is assigned by phonetic interpolation, and thus is rising in (56b) and falling in (56c). Note that (56b, c) both contain P-phrases that are not syntactic constituents.

In our judgment, deaccentuation of this sort is impossible in I-phrase-initial position, even if old information is placed there. Apparently, a pitch accent is needed initially on purely phonological grounds, to provide a phonological specification for the pitch contour.

This relation between information content and accentuation calls for further consideration of the semantics of the L* H_P sequence. Leaving aside cases of fast-speech reduction, we can discern three relevant categories: (a) Constituents bearing L* H_P under nuclear stress. Semantically, these always bear narrow focus. (b) Constituents bearing L* H_P within the head. These do not seem to be *focused* in a strict sense, but nonetheless are marked as more informationally salient than: (c) Prenuclear constituents bearing no pitch accent at all and phrased as a phonological dependent of a neighboring constituent. It appears, then, that a more general account of L* H_P would be that it marks informationally prominent items, and interacts with the phrasal stress system in marking narrow focus.

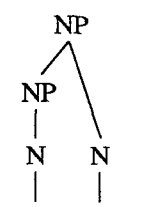
The two factors discussed in this section, speaking rate and information content, are variable in extent and can reinforce or cancel one another. Constituents forming old information are likely to be phrased separately if the speaking rate is slow enough; and at high speaking rates, constituents forming new information can be phrased together.

9.4. *P-Phrase Construction Rules*

A full account of phonological phrasing in Bengali must provide an algorithm whereby phrasing can be derived from syntactic structure. We propose a default algorithm with additional rules that may override it.

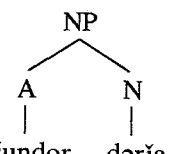
Default P-phrasing in Bengali follows a typical pattern for head-final languages: a syntactic head may phrase together with a constituent that precedes it within its maximal projection (cf. Kaisse (1985) for Gilyak, Selkirk and Tateishi (forthcoming) for Japanese). For example, the following syntactic constituents in Bengali typically would form a single P-phrase:

(57)a.



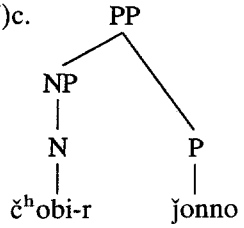
Ram's money

b.



beautiful door

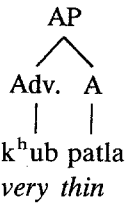
(57)c.



pictures-gen. for

for pictures

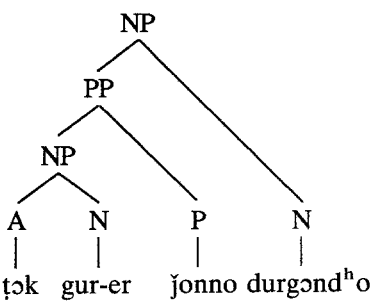
d.



very thin

P-phrasing is recursive, in the following sense: in a string of heads, each of which c-commands a maximal projection on its left, the whole string may form a single P-phrase, as in (58):

(58)



sour molasses for bad-smell

the bad smell of sour molasses

For this reason, our formal rule for normal P-phrase construction is expressed recursively, as a licensing condition on possible P-phrases.

(59) *Default P-phrasing* (*preliminary version*)
a. Every phonological word may be a P-phrase.
b. For two consecutive constituents X, Y: if
i. X forms a legal P-phrase
ii. Y is a head c-commanding X
then [XY] may form a P-phrase.

For example, in (58) *ʈɔk*, as a phonological word, is a legal P-phrase. *Gur-er* is a head c-commanding *ʈɔk*, so *ʈɔk gur-er* is a legal P-phrase. *J̌onno* is a head c-commanding *ʈɔk gur-er*, so *ʈɔk gur-er ǰonno* is a legal P-phrase. Finally, *durgɔndʰo* is a head c-commanding *ʈɔk gur-er ǰonno*, so *ʈɔk gur-er ǰonno durgɔndʰo* is a legal P-phrase. At every stage, P-phrase formation is optional, so the following possibilities are all allowed:

(60)a. [ṭɔk]$_P$ [gur-er]$_P$ [ǰonno]$_P$ [durgɔnd^{h}o]$_P$
b. [ṭɔk gur-er]$_P$ [ǰonno]$_P$ [durgɔnd^{h}o]$_P$
c. [ṭɔk gur-er ǰonno]$_P$ [durgɔnd^{h}o]$_P$
d. [ṭɔk gur-er ǰonno durgɔnd^{h}o]$_P$

Rule (59) is stated only as a rough approximation, to which we will now add some refinements. To account for the effects of focus on P-phrasing, we propose the following rule:

(61) *Focus Marking*
A focused constituent must be followed by]$_P$.

This formulation refines our earlier statement from Section 4.2, which required that a focused constituent be entirely coextensive with a P-phrase. The change is made necessary by examples like (56c), where the P-phrase of the focused constituent *tara-ke* is augmented by the preceding deaccented constituent *čador*; thus the focused constituent ends, but does not begin, with a P-phrase boundary. The mirror-image case, where a focused constituent is augmented with following deaccented material, does not occur. For example, (62), where *čador* and *tara-ke* are construed as old information, is ill-formed:

(62) . . . *[[ar ɔmor čador]$_P$ [tara-ke]$_P$ [dieč^{h}e]$_P$]$_I$
| | |
L* H$_P$ L$_I$
and Amor scarf Tara-obj. gave
. . . and *Amor* gave a scarf to Tara.

In (60), if *ṭɔk* 'sour' is focused, only (60a) is allowed, since in (60b–d) the focused constituent would not be followed by]$_P$. We note that the same asymmetry with regard to focus is found in Chichewa (Kanerva 1990), where just as in Bengali, focused constituents must be followed by]$_P$, but need not be preceded by [$_P$.

Where applicable, Focus Marking overrides all other phrasing rules.

Another, rather unusual factor we have noted in Bengali phrasing is that verbs must be phrased separately. For example, in (54), even though the NP *tara-ke* 'Tara-obj.' is c-commanded by the verb *dieč^{h}e* 'gave', the two cannot phrase together. We therefore add the following condition to (59b):

(63)iii. Y ≠ V

We conjecture that (63) is functionally motivated: it guarantees that VP's of the form NP + V will receive a different phrasing than N-V

compounds, which are very frequent in Bengali. The functional value of phrasing verbs separately can be seen in the following example, in which otherwise homophonous sentences are disambiguated by phrasing:

(64)a. *N-V Compound*

L* H_P L* H_P L_I
[[ami]$_P$ [b^{h}út dek^{h}lam]$_P$]$_I$
[d d]
I ghost saw

I ghost-saw. = I was startled.

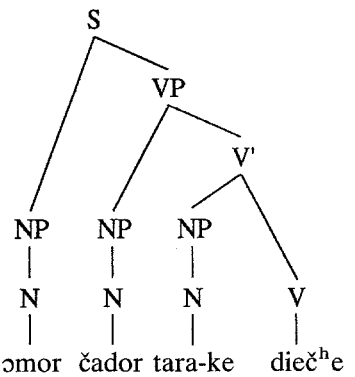
b. *Object + Verb*

L* H_P L*H_P L_I
[[ami]$_P$ [b^{h}út]$_P$ [dek^{h}lam]$_P$]$_I$
[t] [d]
I ghost saw

I saw a ghost.

We noted earlier that under certain conditions, it is possible to form larger P-phrases: this may occur when a constituent is deaccented, or in the context of fast speech. An example of the latter is (54), repeated below with its syntactic structure:

(65)a.



Amor scarf Tara-obj. gave

Amor gave the scarf to Tara

b. i. [ɔmor]$_P$ [čador]$_P$ [tara-ke]$_P$ [dieč^{h}e]$_P$
ii. [ɔmor čador]$_P$ [tara-ke]$_P$ [dieč^{h}e]$_P$

iii. [ɔmor]$_P$ [čador tara-ke]$_P$ [dieč^{h}e]$_P$
iv. [ɔmor čador tara-ke]$_P$ [dieč^{h}e]$_P$

To accommodate the free variation shown in (65b), we add an additional rule of restructuring, which we state as follows:

(66) *P-phrase Restructuring*
Where X and Y are consecutive permissible P-phrases, [XY] may form a P-phrase, provided one of the following conditions are met:
i. Rapid speaking rate.
ii. X or Y is a non-initial constituent constituting old information in the discourse.

The fast-speech provision of P-phrase Restructuring (66.i) can be observed applying in (65): if we take X to be *ɔmor* and Y to be *čador*, then in fast speech *ɔmor čador* may be a P-phrase (cf. (65b.ii)). We can similarly adjoin *čador* and *tara-ke* to derive (65b.iii); and assuming that adjunction can apply more than once, we can also derive (65b.iv). In each case the verb must be phrased separately, following (63).

In (56b, c), clause (66.ii) of P-phrase Restructuring applies. The word *čador*, which is non-initial and constitutes old information in the discourse, may be analyzed as X in the restructuring rule, and thus adjoin rightward (56c); or it may be analyzed as Y and adjoin leftward (56b). By (63), verbs are exempt from adjunction even when they are old information.

Before we present the final formulation of our phrasing rules, one further change is needed, to account for a difference between left- and right-branching structures. Consider the left-branching (60). Here, one of the possible phrasings makes every word a separate P-phrase: [*ṭɔk*]$_P$ [*gur-er*]$_P$ [*ǰonno*]$_P$ [*durgɔnd^{h}o*]$_P$. Now, we have just claimed that in fast speech, adjacent P-phrases may be adjoined to form larger P-phrases. But in a left-branching utterance, this produces ill-formed results. For example, adjoining *ǰonno* and *durgɔnd^{h}o* we get *[*ṭɔk*]$_P$ [*gur-er*]$_P$ [*ǰonno durgɔnd^{h}o*]$_P$, which is impossible even under conditions of fast speech or deaccenting. Similarly, the phrasings *[*ṭɔk*]$_P$ [*gur-er ǰonno*]$_P$ [*durgɔnd^{h}o*]$_P$ and *[*ṭɔk*]$_P$ [*gur-er ǰonno durgɔnd^{h}o*]$_P$ are excluded. The generalization is that in left-branching structures like (60) only syntactic constituents may form P-phrases, but in right-branching structures like (65) non-constituents may form P-phrases in fast speech or with deaccenting.

To account for the difference, we propose the following further restriction on P-phrase Restructuring (66): X and Y may be grouped into a

single P-phrase only if X c-commands Y. (Our definition of c-command is: X c-commands Y iff the minimal branching node dominating X dominates Y.)

To see how this works, compare right-branching (65) with left-branching (60). In (65), the NP *čador* c-commands the NP *tara-ke*, under our definition of c-command. Taking X to be *čador* and Y to be *tara-ke*, we license (in fast speech) the P-phrase *čador tara-ke*. Consider next the corresponding words in left-branching (60). Here, X would be *gur-er* and Y *ǰonno*, but we cannot form a P-phrase out of them, even in fast speech, because *gur-er* does not c-command *ǰonno*. Thus our requirement that X c-command Y captures the crucial distinction between left- and right-branching structures. Moreover, it is also compatible with the data presented earlier.

We summarize our findings with the following final versions of our rules:

(67) *Default P-phrasing*
a. Every phonological word may be a P-phrase.
b. For consecutive constituents X, Y: if
i. X forms a legal P-phrase
ii. Y is a head c-commanding X.
iii. $Y \neq V$
then [XY] may form a P-phrase.

(68) *Focus Marking*
A focused constituent must be followed by $]_P$

(69) *P-phrase Restructuring*
Where X and Y are consecutive permissible P-phrases, [XY] may form a P-phrase, provided the following conditions are met:
a. X c-commands Y.
b. One of the following:
i. Rapid speaking rate.
ii. X or Y is a non-initial constituent constituting old information in the discourse.

10. Conclusions

From our study of Bengali intonation we draw the following theoretical conclusions.

First, we have found that despite the rather different status of stress in Bengali and English, the two languages have the same kinds of tune-text

association rules. In particular, although Bengali stress is usually quite weak and is completely predictable, we find the same attraction of pitch accents to stressed syllables as in English. The difference between the two languages is large regarding the phonetics of stress, but relatively small regarding intonational phonology.

Second, we have found full agreement between the domains needed to describe phonological juncture and those needed to describe the intonational system, suggesting that both domains are under the control of a single Prosodic Hierarchy.

Third, Bengali provides support for Beckman and Pierrehumbert's (1986) proposal that the so-called "phrase accent" is in fact a boundary tone for a smaller level of phrasing. The salient "phrase accent" of Bengali, the H_P tone, is quite clearly a boundary tone, since it serves the function of marking the right edge of the focused P-phrase, and in this function can create minimal contrasts. More generally, our findings are compatible with a theory in which the only kinds of intonational tones are pitch accents and boundary tones.

Fourth, our data support the long standing claim that languages can have true phonological phrasal stress assignment rules, and tend to refute the view that phrasal stress assignment reflects only focus and other discourse factors. The reason is that whenever focus determines stress placement in Bengali, it is obligatorily signaled by the use of the focus nucleus, namely $L^* H_P L_I$. In contrast, the H^* and $L + H^*$ pitch accents may occur only in neutral-focus contexts. The facts that these pitch accents occur only on final P-phrases shows that a true phonological rule (i.e. the I-phrase Stress Rule (13)) assigns main stress to this position.

Fifth, Bengali provides a case for the existence of phonological rules within the intonational system: our rule of H_P Deletion makes possible a unified account of the distribution of the focus accent.

Finally, our study indicates that the Bengali intonational inventory obeys the Obligatory Contour Principle. We suggest that conforming to the OCP is a parametric option available to intonational languages as well as to tone languages.

Appendix: Phonetic Implementation

A full account of Bengali intonation would provide phonetic rules to convert the phonological tones into actual pitch contours. We are not ready to provide such rules here, but we have found some of the generalizations that the phonetic rules would have to capture. Since none of these

observations have been verified by rigorous experiments, our summary will be brief.

Timing. Pitch accents usually produce peaks or valleys fairly late in their syllable or even slightly after it. An exception is found in phrase-final syllables, where the peak or valley occurs earlier. H_I and L_I when alone usually result in rises and falls extending to the very end of the I-phrase, and thus could be said to be strictly I-phrase final in phonetic representation. $H_I\ L_I$ and $L_I\ H_I$ sequences are executed rapidly during the last one or two syllables. As noted in Section 4.3, H_P tends to be aligned in time with its boundary rather loosely.

Pitch Values. As in other languages, there is a great deal of variation in the pitch of individual tones in response to stress levels and the speaker's overall choice of pitch range. H is higher than L when in the same context, but not necessarily across contexts.

In general, as stress or overall pitch range is increased, all tones get higher. There are two exceptions: L* when it is not followed by H_P, and L_I when it is the only final boundary tone. The latter tones stay at roughly the same (fairly low) value when overall pitch range is increased.

There appears to be a general pattern that governs the scaling of tones: those tones which characteristically get assigned the highest pitch values (for example, H* and H_I not preceded by L_I) are also the tones that vary the most when overall pitch range is varied. (Compare for English Liberman and Pierrehumbert (1984), Pierrehumbert and Beckman and Ladd (forthcoming)).

Interpolation. Since Bengali tunes obey the OCP, interpolation is always between H and L. If tones are close together in time, interpolation follows more or less a straight line. For tones that are more separated, we usually find a certain amount of sag: in either direction (H to L, or L to H), the slope of the curve is steeper at the H end than at the L end. The amount of sag varies, but the interpolated pitch never sinks below the target for the L tone. That is, although some interpolations have a fairly long flat section, none have an actual fall + rise.

A full account of Bengali intonation would require a complete and explicit set of phonetic rules, justified by controlled experiments. Our investigation has been phonological in nature, directed toward the logically prior task of finding the structural principles that underlie the pitch contours. The phonetic data we have gathered suggest that it should be feasible to develop a set of phonetic rules that would derive pitch curves from our phonological representations, and we hope to turn to this task in future work.

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