A Preliminary Study of Hindi Intonation

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Abstract

We present a study which investigates the phonological structure of Hindi declarative and interrogative tunes, using the autosegmental-metrical (AM) framework developed by Pierrehumbert [1] and others. This study finds that Hindi is an accentual phrase (AP) language and the AP is the smallest tonally marked unit which carries the pitch accent. The default pitch accent is found to be L*+H, a bitonal pitch accent. This study also finds that Hindi supports three types of phrasal tones, namely, accentual phrase (AP), intermediate phrase (ip) and intonational phrase (Ip). The Ip differentiates the different sentence types.

Index Terms: Hindi intonation, accentual phrase, intermediate phrase, intonational phrase

1. Introduction

Both Hindi and English belong to the Indo-European branch of languages. English has received a great deal of attention. Surprisingly not much is known about Hindi. One would expect that Hindi and English would show similar intonational structure but that is not the case. Previous research on English shows that an utterance usually can be tokenized into many smaller constituents at different prosodic levels (Pierrehumbert and others), such as intonational phrase (Ip), intermediate phrase (ip) and nuclear accent (i.e. pitch accent on the last stressed syllable in the ip). Prosodic prominence in English is attributed to the nuclear accent in the ip. However, in Hindi we will show that the prosodic structure is quite different from English. Instead, Hindi is an accentual phrase (AP) language and the AP is the smallest tonally marked unit. Every AP is marked by one and only one pitch accent which creates prominence/emphasis within a Hindi sentence. The default pitch accent found is the rising pitch which rises continuously from the left most edge of the AP to the highest point on one or more syllables in the AP and declines from there to the beginning of the next AP. The domain of the AP is one or more words and is quite similar to Korean [2] and Bengali [8].

The domain of the Ip is the sentence and the boundary tone is aligned to the right most edge (it is the terminal tone). We will show that the terminal tone is low (L%) for declaratives and high (H%) for interrogatives. Whereas, the ip is characterized as a grouping of AP’s that often corresponds to a phrase (e.g. topic, adverbial etc.) and is followed by a small silence. The silence creates a juncture between two ip’s and because of this the speaker is free to reset the pitch range of the following ip. These units can be organized as shown in Figure 1.

The purpose of this study is to provide a basic prosodic structure of Hindi and that these results could offer a foundation to future studies related to Hindi prosody (such as ToBI characterization and speech synthesis).

2. Previous Works on Hindi Intonation

A number of studies on Hindi Intonation have been reported in literature so far. The three most complete studies were Robert Moore [4], James Harnsberger [5] and C. Féry and others [6]. Moore analyzes Hindi Intonation in terms of: expression of emphasis (or focus), expression of attitude and segmentation (or phrasing). He claims that utterances in Hindi are divided, by certain prosodic traits, into three different segmentation levels which stand in a hierarchical relation to each other. These levels are “foot”, “measure” and “sentence”. The “sentence” corresponds to the entire sentence.

Harnsberger also makes a similar observation of a rising pitch contour on content words. He proposes that the low part of the rising contour is a low pitch accent and the high part is either a high trailing tone or boundary tone. He also observes another level of phrasing, the intonation phrase whose domain is the sentence.

C. Féry and others also observe the rising pitch contour on each constituent of the data that they have considered and call it the prosodic phrase (P-phrase) and have related it to the syntax of the sentence. They have considered very simple sentences with three content words and each belongs to the three constituents - subject, object and verb of the sentence. According to them each non-final P-phrase receives a low pitch accent and a high phrase boundary associated with the right edge that can be defined as L*Hp. And the final P-phrase can be defined as H*L% where L% is the low boundary tone of the intonation phrase.

All the above researchers agree that each content word except the final one are associated with a rising pitch contour, and the final one is influenced by the final boundary tone.

3. Participants and Data used

Ten native male speakers of Hindi from Uttar Pradesh (a province in India) participated in this experiment. They were
asked to read the same set of Hindi declarative and interrogative sentences (i.e. each participant read 15 declarative and 10 interrogative sentences). Total data set was 25x10=250 sentences. Out of these sentences, one declarative and one interrogative sentence has been used for discussion here. The recordings were carried out using a digital recording system and a microphone in a very normal home like atmosphere (not in a studio), to avoid any psychological pressure on the participants that could affect natural speech and hence the pitch patterns. They were only asked to repeat the sentence in case of a mistake.

4. Procedure

Each sentence (for all ten speakers) in the data set was annotated using Praat software. Pitch analysis was also done by Praat using the default values. The pitch contours were smoothed using Praat’s smoothing algorithm to diminish microprosodic perturbations. The stylized pitch tracks were generated using momel algorithm and then superimposed onto the actual (smoothed) pitch contours as shown in the figures below for discussion and illustration. Out of the 250 sentences one declarative and one interrogative (spoken by different speakers) is used here for discussion.

4.1 Hindi Sentences for Discussion

Declarative Sentence (dots are syllabic boundaries):

- bhaa.rat ko san un.niis sau sai.taa.liis meM aa.jaa.dii mi.lii
- India ACC year nineteen hundred forty-seven in independence got
- India got independence in year nineteen and forty seven.

Interrogative Sentence:

- bhaa.rat ko kaun se san meM aa.jaa.dii mi.lii
- India ACC which ERG year in independence got
- In which year India got Independence

5. Pitch Plots

The pitch plots of three different speakers for the declarative sentence and three for the interrogative sentence are discussed here. The following notations are used which will be discussed in the next section:

- AP: Accentual Phrase
- T-: Intermediate Phrase(ip)
- L%, H%: Low, High phrasal tone for Ip (ie terminal tone)

5.1 Pitch plots for declarative sentence

The declarative sentence above was spoken by three different speakers. Each speaker has chunked (i.e. phrased) the same sentence in a very different way as shown in the pitch plots below. This difference can be explained by the AP as being an intonation related phrasing and not syntax related. The final AP is overridden by the terminal tone (it is L% in declarative). The domain of the Ip (i.e. terminal tone) is the whole sentence here and depends on the meaning conveyed (as it is a declarative it is a low boundary tone). The Ip was considered to be a phrasing above the AP and below the Ip. It is usually followed by a pause and reset of pitch. We will discuss all the speakers one by one and the brackets [ ] are used to mark the different phrasal boundaries.

Speaker B: The pitch contour from the plot in figure 2 can be described as follows:

- [bhaa.rat ko san AP] [un.niis sau AP] [sai.taa.liis AP] [meM AP] [aa.jaa.dii mi.lii] AP

Speaker B has chunked the utterance into one Ip and five AP. The final AP bears the L%. We can see that the pitch on the first AP rises and then maintains that level till the next word before falling.

Speaker C: The pitch contour from the plot in figure 3 can be described as follows:

- [bhaa.rat ko AP] [san AP] AP [un.niis sau AP] [sai.taa.liis AP] [meM AP] AP [aa.jaa.dii mi.lii] AP

Speaker C has chunked the utterance into one Ip, three Ip and six AP. The chunking of the AP and Ip is quite different from the other speakers. Here the first AP has only two words.
**Speaker D**: The pitch contour from the plot in Figure 4 can be described as follows:

\[
[ \text{bhaa.rat} \text{ ko} ]_\text{AP} [\text{san} ]_\text{AP} [\text{un.niis sau} ]_\text{AP} [\text{ sai.taa.liis meM } ]_\text{AP} [\text{aa.jaa.dii mi.lii} ]_\text{AP} \]

Figure 4: Pitch contour plot for Speaker D

Speaker D has chunked the utterance into one Ip and five AP.

5.2. Pitch plots for interrogative sentence

The interrogative sentence spoken by three different speakers are discussed below. Everything is similar to the declaratives except the final AP which has its accent overridden by the terminal tone and it is H% here.

**Speaker PI**: The pitch contour in Figure 5 can be described as follows:

\[
[\text{bhaa.rat} \text{ ko} ]_\text{AP} [\text{kaun se san meM } ]_\text{AP} [\text{aa.jaa.dii mi.lii} ]_\text{AP} \]

Figure 5: Pitch contour plot for Speaker PI

Speaker PI has chunked the utterance into one Ip, two Ip and five AP. The last AP has two words, which is overridden by the boundary tone H%.

**Speaker Sk**: The pitch contour in Figure 6 can be described as follows:

\[
[\text{bhaa.rat} \text{ ko } ]_\text{AP} [\text{kaun se san meM } ]_\text{AP} [\text{aa.jaa.dii mi.lii} ]_\text{AP} \]

Figure 6: Pitch contour plot for Speaker Sk

Speaker Sk has chunked the utterance into one Ip and three AP. The last AP is overridden by the boundary tone H%. The second AP has four words.

**Speaker SL**: The pitch contour in Figure 7 can be described as follows:

\[
[\text{bhaa.rat} \text{ ko } ]_\text{AP} [\text{kaun se san meM } ]_\text{AP} [\text{aa.jaa.dii mi.lii} ]_\text{AP} \]

Figure 7: Pitch contour plot for Speaker SL

Speaker SL has chunked the utterance into one Ip and four AP. The last AP is overridden by the boundary tone H%.

6. Results and Discussion

It is clear from the above plots that the same sentence, spoken by different speakers, has been chunked/phrased differently and each chunk is marked by a rising or level pitch pattern. As the phrasing is different for different speakers it is quite obvious that the phrasing is not strictly syntax related, rather, it is defined by the surface tonal pattern which may be
influenced by syntactic and non-syntactic factors yet to be discovered. It is proposed that the basic prosodic unit of Hindi intonation is the accentual phrase (AP) and this is marked by a rising or level pitch pattern similar to Bengali intonation proposed by Khan [8] and Jun [2]. The AP is the smallest tonally marked prosodic unit and corresponds to a single word or a small group of words within a sentence. The APs within an utterance can be affected by factors like speech rate, focus, word length, size of phrase; see Jun [2]. However, this claim needs further research on Hindi data.

In our entire data set the relationship of rising pitch (LH) to AP is one to one i.e. every AP will have only one LH which marks the head of the AP and starts on the first word. Also, in the entire dataset the distance from the low target (L) to the high target (H) is not more than 3 syllables, even though the number of syllables in some of the APs were much greater than three. The LH is comparable to the focused AP in Bengali (Khan 2008) where the H tone is tied to the L tone, because the maximum duration seen between them is not more than three syllables (it is usually two syllables). However, if the H target remains within a fixed distance from the L target (referring to the number of syllables intervening between the L and H target) it is more likely a left anchored tone (i.e. a pitch accent) and not a boundary tone. I argue that it is a bitonal pitch accent $L^* + H$. Harnsberger (1994), has also indicated that the LH is more likely a pitch accent.

Pierrehumbert (1980), on the other hand, has also shown that the H target of the $L^*+H$ pitch accent is at a fixed distance from $L^*$; and that this fixed time arises as the amount of time needed to execute the change in pitch level specified by the pitch accent. She also mentions that this time would increase with overall pitch range.

Pierrehumbert (1980) also mentions the concept of tonal spreading. She explains that the unstarrred tone of a bitonal pitch accent (H target here) is subject to tone spreading to the right when the next tone is phonetically equal or higher. This phenomena has already been shown above by Speaker B in the AP “bhaa.rat ko san”; this also supports the finding that LH in the present data is $L^*+H$.

For the L target (in LH) to be a low pitch accent (i.e. $L^*$), means the syllable that carries the L target should be, in Hindi, a stressed syllable of the first word of the AP. This is supported by Hussain (1997), Nair (2001) and Dynd (2001); they show that the pitch is a correlate of stress in Hindi-Urdu and the stress tends to correlate with low pitch on the stressed syllable.

On the basis of above discussion, we can hypothesize that the most basic intonation pattern of Hindi sentence with N number of words can be schematized as shown in Figure 8 below.

$$L^*+H \quad L^*+H \quad L^*+H \quad L^*+H$$

Where $B\% = L\%$ for declarative tune

$$= H\%$$

for interrogative tune

| [word_1]AP | [word_2]AP | [word_N-1]AP | [word_N]AP |

Figure 8: Basic intonation pattern of Hindi sentence

Ideally, the maximum number of APs in a sentence are equal to the number of words in the sentence. The speech rate, focus, level of prominence etc are most likely to reduce the number of APs in a sentence i.e. APs tend to be multi-word. Within a sentence the prominences are created by the APs and the degree of prominence of each AP depends on the range of the rise within the AP. It is because of this rise-fall pattern of APs most non-Hindi speakers say Hindi sounds very singsong. Robert Moore.[4] has talked of the “measure” in his work, which he proposes as a level of phrasing that ends with a peak of relatively strong emphasis and that each measure contains at least one foot (indicated by a rising pitch). He also mentions that this gives Hindi sentences the aspect of a series of waves. Though it is not very clear, it looks as if it is similar to the AP we have proposed.

The last AP is overridden by the intonation phrase boundary tone as shown above and it depends on the meaning conveyed. The speakers are more likely to introduce an ip when the sentences become longer. The ip is characterized as a grouping of AP’s that often corresponds to a phrase (e.g. topic, adverbial etc.) and is followed by a small silence. The silence creates a juncture between two ip’s and because of this the speaker is free to reset the pitch range of the following ip. Hence, we can propose that Hindi Intonation has three levels of prosodic phrasing, namely, AP, ip and Ip. And they can be hierarchically organized as shown in Figure 1.

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### 8. References


