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Acoustic Correlates of Stress in Mizo, a Tonal Language

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Abstract

As, tone languages use pitch and stress to signal a difference in meaning between words (A very 1977), , the acoustic factors which contribute to this stress patterns in tone languages may differ from the stress patterns in non tone language. Hence the present study aimed at identifying the acoustic correlates of stress in the Mizo language.

A total of 22 native Mizo speakers participated in the study. Ten Mizo phrases were selected. All the speakers were asked to say those phrases in stressed and unstressed conditions. Recorded phrases were subjected to acoustical analysis and Tone Duration, Tone Height and Peak Amplitude was measured and S-ratios for the same parameters were calculated.

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The results indicated that tone speakers give stress by increasing the duration of the word or the syllable and also, they perceive stress with increased duration of the word or the syllable. Tone duration was the major cue for stress in Mizo language which is in consonance with other studies in tone languages. The obtained data will foster our understanding of the behavior of stress in tone languages. It will provide a thrust to the long felt need for research in the field of prosody in tonal languages of India.

Introduction

A tonal language is one having a lexically significant, contrastive but relative pitch on each syllable (Beach, 1924). Tone language has four basic characteristics:

- i. Lexically significant pitch (pitch distinguishes the meanings of words).
- ii. Contrastive pitch (pitch that can be differing within a functional system).
- iii. Relative pitch (relative height of the toneme)
- iv. Significant pitch unit.

Most frequently there is one to one correlation between the number of syllables and the number of tonemes in any specific word. However, a syllable may have more than one toneme, or a combination of tonemes.

Tone in Linguistic Descriptions

Tone was not part of the European philological tradition which provided the frame work for the description of languages before the 20th century. While concepts such as quality, accent, were familiar to classical scholars before the rise of linguistics in the modern sense, this is not true of tone. The reasons for this are clear as none of the major European languages are tone languages in the full sense, and acquaintance with non-European languages was quite limited before the modern era.

Similar is the situation within Indian linguistic traditions as well. A lot of effort has gone into the description of sentence intonations, both in the Sanskrit and non-Sanskrit (Tamil) traditional grammars. Meaning differences caused by intonations in sentence level have been described elaborately, taking into consideration both (linguistic) structural and social implications. But, as tone was not very significant in most of the Indian languages, and as Punjabi was yet to be

described in great detail within Indian traditions, tone did not receive much attention, although there are some references to the role of tone in these grammatical traditions.

The role of tone in some of the world's languages had nevertheless begun to be appreciated in the course of the nineteenth century, primarily as a result of the linguistic activities of European missionaries in Africa and Asia.

Tonal Languages in the World

The languages of South Eastern Asia, (China, and Indo-China) and West and South Africa (Sudanic, Bantu, Bushman and the Hottentot group) are largely tonal (Tucker, 1940). In North America, various tone languages are found in South Western (Mexico, Mazateco, Otomi, Tlapaneco, Trique and Zapoteco) regions. There are very few studies on tone languages spoken in North- Eastern part of India (Manipuri, Mizo and Naga languages), which belong to Kuki-chin group of the Tibeto Chinese subfamily.

Efforts have been made to investigate the production and perception of tone in past. Researchers have tried to investigate the type of tones, its perception and cues used by the native and non native speakers for the perception, identification and discrimination of tones. Most of these studies are on Cantonese, Thai and Mandarin-Chinese languages.

Study of Tonal Languages of India

Early studies of Indian languages spoken in the Himalayan region and in the North-Eastern region of India (Assam, Nagaland, Manipur, Arunachal, etc.) have attempted to detail aspects of tones in the Tibeto-Burman family of languages. *Linguistic Survey of India* volumes edited by G.A. Grierson consistently make it a point to describe the tones used in these languages and used a variety of tones even to sub-classify these languages under various groups, apart from using a number of morphological, syntactic and semantic features for the purpose.

There are a good number of studies on the tone languages of India in recent decades. Central Institute of Indian Languages in Mysore, Karnataka, have come up with various phonetic readers of several Tibeto-Burman languages, such Manipuri, Thadou, Ao Naga, Angami Naga, etc., including several languages spoken in the Ladakh region as well as other Himalayan regions. Researchers at the Department of Linguistics, University of Delhi have also focused on the study

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of the languages of the North-Eastern India, which has many tonal languages. A few researchers (Radhakrishnan, 2005; Rohini, 2007) have studied the types of tone in Mizo and Manipuri language and the perception of these tones by native and non-native speakers.

Suprasegmental

The term “suprasegmental” refers to those properties of an utterance which do not belong to any single segment. The supra segmental properties are stress, tone, intonation, length and organization of segments into syllables. Sweet (1878) was the first one to talk about stress. He said that stress is a comparative force and called it as extra physical effort.

Bolinger (1958) and Jassem & Gibbon (1980) regard stress as an abstract category, as potential accent, and ‘accent’ as its observable manifestation. Abercrombie (1976) and Laver (1994) regarded accent as potential for stress and stress as the actual physical occurrence of it. Bolinger (1958) implies the possibility of more and less prominent pitch accent by referring to stress as ‘the most prominent one in the utterances’. The acoustic correlate of stress varies depending on the language under the study.

Stress is cued by acoustic parameters such as increased F0, increased A0, prolonged duration or change in the vowel quality. The importance of these parameters indicating stress is language dependant. Stress is the relative force with which a given sound, syllable or word is pronounced. Stress is assigned to that syllable of a word which stands out more conspicuously. It is conveyed by variation of frequency, intonation, duration and pause (Hargrove and McGarr, 1994). While in languages such as English (Bolinger, 1958; Morton & Jassem, 1965), Polish (Jassem, Morten & Steffen-Botog, 1968) and French (Rigault, 1962), Fo is the primary acoustic correlate of stress whereas duration is found to be major correlate in Swedish (Westin, Buddenhagen & Obrecht, 1966), Estonian (Lehiste, 1968a), Italian (Bertinetto, 1980), Tamil (Balasubramanyam, 1981), and Kannada (Savithri, 1987; Raju Pratap, 1991; Savithri 1999).

Very few studies on stress have been done in Indian languages. Some of the works done in Indian languages are summarized in the table 1.

Language	Author	Year	Cue for stress
Kannada	Rathna et al,	1981	Do, Ao
Kannada	Savithri	1987	Do
Kannada	Raju Prathap	1991	Do
Kannada	Savithri	1999	Do
Hindi	Ruchi et. al.	2007	Do, Fo

Table 1: Cues for stress in different languages (Indian studies)

Pitch and Stress

Tone languages use pitch and stress to signal a difference in meaning between words (Avery 1977), these pitch variations are an important part of the language. In these languages, word meanings or grammatical categories such as tense are dependent on stress. Stress is assigned to that syllable of a word which stands out more conspicuously. There may be various acoustic factors which contribute to this stress patterns in tonal languages. Duration was the major cue for stress in Serbo-Croatian which is a tone language. So, the present study will help in understanding factors related to the stress patterns in the tonal language.

Need for the study

India is a country with a variety of languages, Dravidian, Indo-Aryan, Austric and Tibeto-Burman. In the past, several studies on perceptual and acoustic correlates of stress have been carried out in Indian languages, especially in Indo-Aryan and Dravidian languages. There are no studies analyzing stress in tone languages of India. Hence, the present study was planned.

Aim of the study

To identify the acoustic correlates of stress in the Mizo language.

Methodology

Subjects – A total 22 native Mizo speakers (11 males and 11 females) in the age range of 20-23 years served as the subjects for the study. All subjects were native Mizo speakers pursuing their graduation in LL.B at Mysore University. They were screened for any speech, language, hearing, cognitive and neurological deficits.

Material – Ten Mizo phrases (noun + adjective) served as the stimuli. Geminate clusters and aspirated syllables were avoided during the selection of stimuli and a constant syllable length was maintained in the phrases. Table 2 shows the stimuli used for the study.

Sl/No.	Phrases
1.	in lian
2.	dhokan sein
3.	sakour dum
4.	kor moi
5.	in moi
6.	lirthei thar
7.	kezungpui the
8.	kong zau
9.	mi the
10.	puan var

Table 2: phrases used for the study

Procedure – The subjects were asked to say each phrase in two conditions; first, with no stress i.e., speaking as naturally as possible and secondly, stressing the second word i.e., the adjective.

The stimuli were recorded using sandisk m200 digital recorder. It was digitized at a sampling frequency of 16 KHz using a 12 bit A/D converter and during the recording, speakers were seated comfortably in noise-free environment and the microphone was placed at a distance of 8-10 cm from the mouth.

Two Mizo native speakers listened to the recorded samples of the subjects and were asked whether the two conditions (stressed and unstressed) were produced correctly or not. Out of 22 subjects, 2 speakers' data was eliminated from the study as the stress pattern produced by them was judged inappropriate by the Mizo listeners. All the phrases (400 phrases) were subjected to acoustic analyses using PRAAT software (version 4.5.06; Paul and David 2006; University of Amsterdam) and the following parameters were extracted:

- a) Tone Height (TH) will be measured as the difference between the starting (A) and ending point (B) of Fo contour. $TH = A - B$ (in Hz).
- b) Tone duration (TD) will be measured as the time difference between the starting and ending point of the Fo contour (in msc).
- c) Peak Intensity/ Amplitude (PA) will be measured as the maximum intensity in the utterance (in dB).

S-Ratio i.e., difference between stressed and unstressed words for males and females were found and tabulated.

Statistical analysis – Paired sample t-Test at 0.01 level of significance was done to compare the acoustical correlates of stress (Tone Height, Tone Duration and Peak Amplitude) across two conditions (stressed and unstressed). SPSS software (10th version) was used for analysis.

Results & discussion

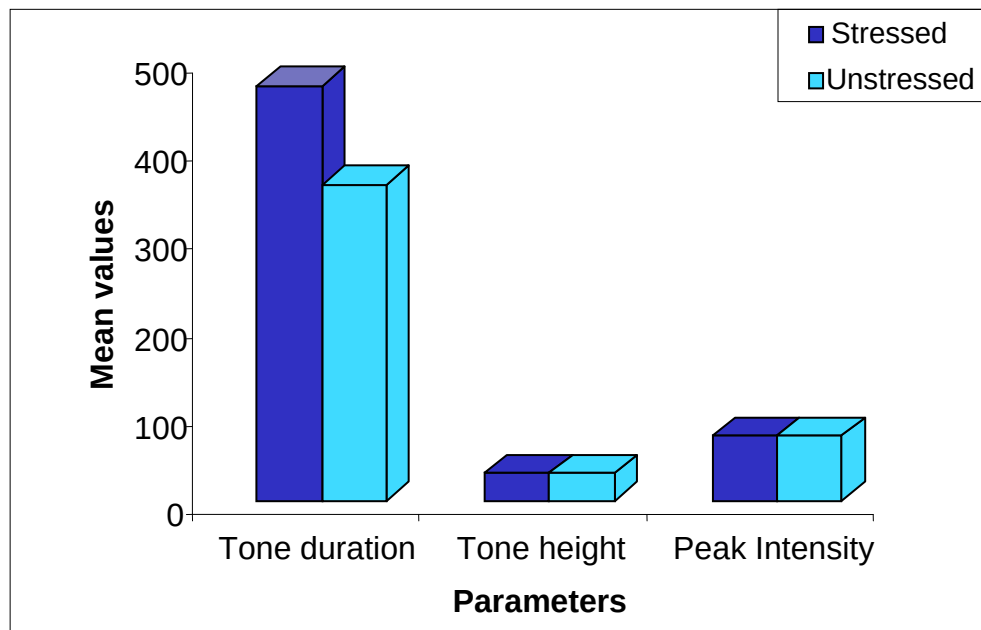
The present study aimed at analyzing the acoustic correlates of stress patterns in the Mizo language. Paired sample t-Test was done to compare the three acoustical correlates of stress (Tone Height, Tone Duration and Peak Amplitude) for two conditions (stressed and unstressed). Mean and standard deviation of TH, TD, and PA for stressed and unstressed condition are depicted in table 3.

Correlates	Condition	Mean	SD
TD	Stressed	470.18	95.15
	Unstressed	358.65	78.35
TH	Stressed	31.37	21.37
	Unstressed	30.42	18.12

PA	Stressed	74.06	9.52
	Unstressed	73.59	9.65

Table 3: Mean and Standard Deviation of TD, TH and PA for Stressed and Unstressed words.

There was a statistically significant difference found between stressed and unstressed conditions ($t = 111.52$, $p < 0.01$) for TD. But there was no significant difference found for TH ($t = 0.953$, $p > 0.01$) and PA ($t = 0.465$, $p > 0.01$) for stressed and unstressed conditions. Graph 1 depicts mean values for TD, TH and PA for Stressed and Unstressed conditions which clearly indicates that the TD was significantly different for both the conditions than TH and PA.



Graph 1: Mean values for TD, TH and PA for Stressed and Unstressed conditions.

The results of acoustic analysis indicated that tone duration (TD) was the major cue for stress in Mizo language. This is further supported by a very high S-ratio obtained for TD (Table 4).

Acoustic cues	S –ratio
Tone Duration (msec)	120.46
Tone Height (Hz)	2.31
Peak Intensity/ Amplitude (dB)	4.17

Table 4: S-ratio for tone duration tone height, and peak intensity/ amplitude for stressed and unstressed conditions.

Results indicated that tone speakers give stress by increasing the duration of the word or the syllable and they also perceive the stress with increased duration of the word or the syllable. The results are in consonance with the studies done on Estonian (Lehiste,1968) and Serbo-Croatian (Rehder,1968).

Thus, this data supports the notion that acoustic cues of stress differs across languages. The relative pitch (i.e.TH) is lexically significant in a tone language, i.e., change in TH changes the meaning of the word. Intensity cannot be a major cue for stress due to various factors such as intrinsic properties of the speech sounds, interaction between Fo & formant data, transition factor, and recording variables. Thus TD can cue stress in tone languages as seen in this study.

Conclusion

In this study we analyzed the acoustic correlates of stress in Mizo language and it was found that the tone duration was the major cue for stress in Mizo language which is in consonance with other studies in tone languages. The obtained data will foster our understanding of the behavior of stress. It will provide a thrust to the long felt need for research in the field of prosody in tonal languages of India. Further, stress analysis should be done on speech and language disorders (like Hearing impairment & dysprosody) in tone language to better understand prosodic deficits in them. It will also be a useful input in text to speech synthesis and can also be used in forensic sciences in the speech identification.

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