Research Article

Acoustic correlates of emphatic stress in Malayalam

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JAIISH(2014)
Vol 33, pp. 59-62

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Key Words

Emphatic stress
Fundamental frequency
Intensity
Malayalam

Abstract

Stress is a perceived prominent function at syllable, word, or sentence level.Emphatic stress is to convey different intents by emphasizing different words in sentences; without changing the meaning. The acoustic correlates ofemphatic stress include increased fundamental frequency, amplitude, and durationvaryingaccording the structure of languages. As there are no reports on acoustic correlates of emphatic stress in Malayalam language, the present study was aimed to investigate the same in Malayalam. A total of 20 native adult speakers of Malayalam with equal number of males and females were selected for the study. The stimuli included 10two word phrases with adjective and verbs/ nouns. The subjects were asked to readthe phrases with and without stress on the adjectives marked in red colour. Recorded stimuli subjected to acoustic analysisto extract the fundamental frequency (f0), intensity (dB) and duration (msec) parameters from the adjective part of each of the phrases using Praat(Version 5.3.17) software. Statistical analysis revealed significant increase in word duration in stressed conditions.

Introduction

Stress is one aspect of prosody and it is the perceived loudness of a syllable/word or greater muscular effort. Physiological and psychological aspects are the two major viewsunderlying the definitionof stress. From speaker's point of view, Lehiste (1970) defined stress as greater effort that enters into the production of a stressed syllable as compared to unstressed syllables. Gatenby (1975) explained it from a listener's viewpoint that stress is the property that endows sequential syllables with differentiating grades of acoustic prominence. Thus, stress indicates both articulatory or motor feature of speech and also perceived sound feature by a listener denoting both the production and the perception of speech. It helps in distribution of stressed elements in speech function for semantic and emotional highlighting by drawing the listener's attention to them (Bolinger, 1972).

Lexical stress and emphatic stress are two types of stress mainly described in literature. Emphatic stress is used to convey a different idea depending on the word position in the phrase ora sentence. Most of the Indian languages are abundant with emphatic stress especially, the Dravidian languages. Stress is cued by acoustic parameters such as increased F0, A0, prolonged duration or change in the vowel quality (Hargrove & McGarr, 1994). In languages such as English (Bolinger, 1958; Morton & Jassem, 1965), Polish (Jassem, Morten & Steffen-Botog, 1968) and French (Rigault, 1962), F0 is the primary acoustic correlate of stress whereas duration of stressed word is found to be major stresscorrelate in Swedish (Westin, Buddenhagen & Obrecht, 1966), Estonian (Lehiste, 1968) and Italian (Bertinetto, 1980).

Past studies in Indian languages also show that the acoustic correlates of stress vary across languages.Tulu speakers use both duration and intensity as cues to indicate emphatic stress(Narra, Teja, Sneha & Dattatreya, 2012) whereas the tone duration was the major cue for stress in Mizo language (Narasimhan, Jose, Hasain & Chand, 2010). Other studies reported that duration alone serves as the major cue in Kannada (Savithri, 1987; Rajupratap, 1991; Savithri, 1999), Konkani (Kumar & Bhat, 2009) and Tamil (Balasubramanyan, 1981). According to Sitapati (1936) and Srinivas (1992), intensity has been reported as a reliable acoustic correlate of stress in Telugu. In Hindi, an Indo Aryan language, duration and fundamental frequency were observed as the major acoustic correlates of stress (Ruchi, Ghosh & Savithri, 2007).Though difference of opinions exist; all authors agree that increments in F0, duration, intensity and alterations in the vowel quality are the primary acoustic cues of stress. Asthere are no reported studies on the acoustical correlates of emphatic stress in Malayalam, the present study was

proposed.

Method

Participants: A total of 20 adult literate native Malayalam speakers including 10 males and 10 females in the age range of 18 to 25 years were recruited. The inclusion criteria was set as subjects who are non-smokers with normal hearing and orofacial structures and with no history of vocal abuse or misuse, exposure to toxic chemicals, or any upper respiratory tract infections.

Test Material: The test material incorporated adjective-verb/noun phrases. Initially twenty phrases were prepared with the first word was an adjective and the second asa verb ora noun. It was ensured that all adjectives selected were trisyllabic words and none of the syllables were aspirated or had geminate clusters. Ten native Malayalam speaking speech language pathologists served as judges for familiarity test. Afour point rating scale was used with zero indicating "not familiar" and 3 for "most familiar". Finally a 10 two- word phrase list of stimuli were prepared which scored 2 (quite familiar) and above(Appendix 1).

Instrumentation: Each subject's speech samples were recorded using a SONY digital recorder ICD-U60 with the microphone position fixed at a constant distance of 10 cm. Speech samples were analysed using the Praat software at a sampling frequency of 22 KHz with 12 bit quantization.

Procedure: Each subject was seated comfortably and tested individually in a quiet room, with minimum interference of background noise. They were instructed to read the written stimuli in two conditions, first without stressing the phrases, as naturally as possible and then by stressing the adjective in each of the phrases. The stressed words were marked in red for all phrases. Before recording, the subjects were allowed to practice the phrases to make sure they were emphasising the adjectives. Praat software was used for the extraction of fundamental frequency, duration and intensity in both unstressed and stressed conditions from the adjectives under study.

Statistical Analyses: Mean and standard deviation (SD) values for each acoustic parameter in stressed and unstressed conditions were tabulated. Paired t-test was used to compute the significant difference between both conditions for peak fundamental frequency, peak intensity and durationusing SPSS 17.0 (Statistical Package for Social Sciences).

Table 1: The mean and SD of fundamental frequency obtained for all the ten adjectives in the two conditions

Groups	Parameters	Mean(Hz) (SD)
Males	FU	131 (9.55)
	FS	157 (11.51)
Females	FU	241 (29.97)
	FS	237 (22.06)

FU- Frequency unstressed; FS- Frequency stressed

Table 2: The mean and SD of intensity for all the ten adjectives in the two conditions

Groups	Parameters	Mean (dB) SD
Males	IU	62.14 (2.74)
	IS	63.5 (2.58)
Females	IU	65.06 (4.08)
	IS	65.27 (4.44)

*IU-Intensity unstressed; IS- Intensity stressed

Table 3: The mean and SD of duration for all the ten adjectives in the two conditions

Gender	Parameters	Mean (msec) SD
Males	DU	0.479 (0.065)
	DS	0.685 (0.054)
Females	DU	0.439 (0.036)
	DS	0.613 (0.068)

*DU-Duration unstressed; DS-Duration stressed

Results

Fundamental Frequency (F0)

Table 1 and Figure 1 display the mean and standard deviation of peak fundamental frequency obtained for all the ten adjectives in the two conditions. As observed the mean fundamental frequency obtained for all the ten adjectives under study in unstressed and stressed conditionsfor females was higher than for males. On statistical analysis, paired t-test revealed no significant difference between unstressed and stressed conditions for both males (p= 0.089) and females (p= 0.424).

Intensity

The mean and standard deviation of intensity obtained for all the ten adjectives in the two conditions are presented in Table 2 and Figure 2. The mean intensity for male subjects was comparatively less in unstressed condition than in stressed conditions. For female subjects, the values were more or less similar in both conditions. Statistical analysis showed a significant difference between unstressed

and stressed conditions at 0.01 level (p=0.007)for males only.

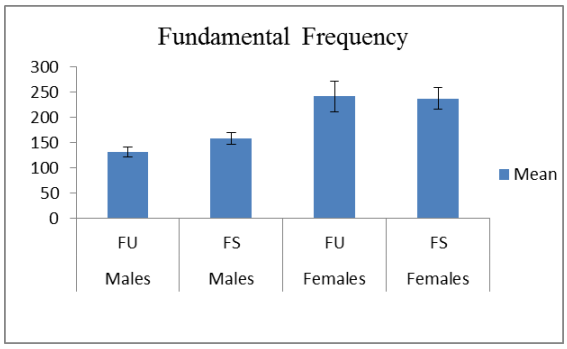

Figure 1: Mean fundamental frequency for unstressed (FU) and stressed (FS) conditions for both males and females

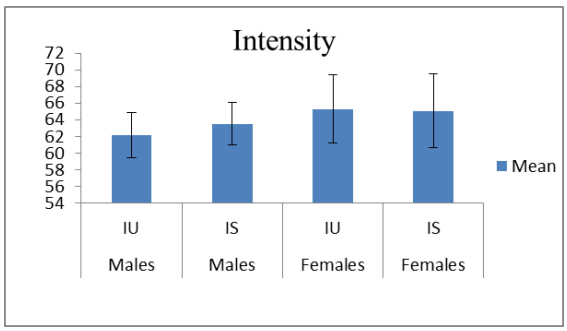

Figure 2: Mean intensity for unstressed (IU) and stressed (IS) conditions for both males and females.

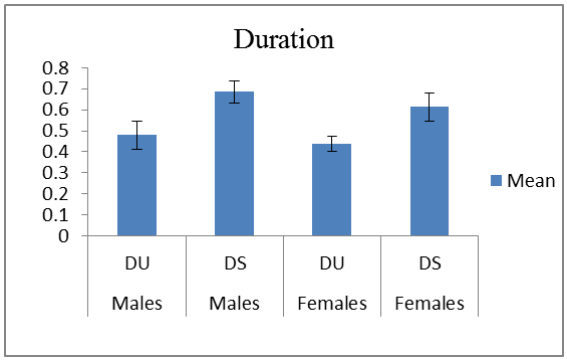

Figure 3: Mean duration for unstressed (DU) and stressed (DS) conditions for both males and females.

Duration

Table 3 and Figure 3 show the mean and standard deviation of duration obtained for all the ten adjectives in both the conditions. The mean word duration obtained was less in unstressed than stressed condition for both males and females. Statistical analysis showed a significant difference between unstressed and stressed conditions; mean duration was higher in stressed condition compared to unstressed condition in both males and females.

Discussion

The present study investigated the acoustic correlates of emphatic stress in Malayalam. As stimuli, a set of ten unstressed and stressed meaningful phrases were prepared and recorded. Acoustic analysis was carried out to examine the role of fundamental frequency, intensity and duration onstressed target stimuli. The results showed that the fundamental frequency was not significant across stressed and unstressed conditions in both males and females. But duration was significantly different in both groups across conditions. Intensity showed interesting finding where only the male participants showed significant difference between emphaticand non-emphatic conditions.

The result of the present study revealed that fundamental frequency is not a significant production cue for emphatic stress in Malayalam: it is in agreement with some of the Indian languages especially Dravidian languages like Tulu (Narra et al, 2012) and Kannada (Savithri, 1987, 1999; Rajupratap, 1991), also with other non-Indian languages like Polish (Jessem et al, 1968), English (Bolinger, 1958; Morton & Jassem, 1965) and French (Rigault, 1962). With respect to intensity, the current study showed significant difference in males between unstressed and stressed conditions which is in agreement with Sitapati (1936) and Srinivas (1992) in Telugu. This inconsistency of results across languages concerning frequency and intensity can be explained as,acoustical correlates of stress are language dependent.

The results of the current study showed duration as amajor production cue of stress which is in congruent with some of the Indian studies (Tulu- Narra et al, 2012; Kannada - Savithri, 1987, 1999; RajuPratap, 1991; Konkani- Kumar & Bhat, 2009; Tamil- Balasubramanyam, 1981). This may be because of the marked durational differences between long and short vowels in these languages. The ratio between the duration of short (lax) and long (tense) vowel is around 1:1.54 in English (Ben-Nett, 1976). However, the ratio is 1:2 in Kannada (Savithri, 1987; Sreedevi, 2000) and 1: 1.89 in Malayalam (Sasidharan, 1995). Cruttenden (1986) explained that the importance of vowel length varies across languages, depending on whether a language usesvowel length for phonemic contrast on the segmental level. And it can be assumed that the differentiation of temporal parameters should be more distinct in Dravidian languages like Kannada and Malayalam.

Conclusions

In the present study, acoustic correlates of emphatic stress were studied in Malayalam speaking

adults. The results showed that there is a significant increase in word duration in stressed condition.When speakers need to convey different communication intents, they increase the word duration. This study is a preliminary step in the direction of understanding emphatic stress in Malayalam.

Acknowledgements

We extend our sincere gratitude to Prof. S.R. Savithri, Director, All India Institute of Speech and Hearing for permitting us to carry out this study. We also thank all the participants of our study for their kind cooperation.

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