

Comparison of Acoustic Correlates of Stress In Gender Within And Across Nepali And Tharu Languages

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Abstract-

Introduction: Each language has its own acoustic pattern and the structure changes based on the linguistic and emotional situations. Acoustic correlates of stress include a change in fundamental frequency, intensity, duration, etc.

Method: 20 Tharu (10:10, males: females), and 20 Nepali speakers (10:10, males: females), between age ranges 18-30 were participated. Ten Nepali phrases and ten Tharu phrases were used and participants were asked to read the two-word phrases with and without stress. The peak fundamental frequencies (Hz), peak intensity (dB), duration (msec) were extracted from the 20 phrases and were subjected to analysis.

Results: It was noted that the significant difference was seen in fundamental frequency, peak intensity, and word duration in both the languages across the gender. While comparing gender within both languages, only fundamental frequency showed a significant difference in both males and females in stressed (S) and (US) conditions.

Conclusion: Therefore, all three parameters that are fundamental frequency, intensity, and duration are primary cues to differentiate between Nepali and Tharu languages across gender in both stressed (S) and unstressed (US) conditions.

Keywords- Duration, Fundamental frequency, Gender, Intensity, Stress

I. INTRODUCTION

Stress comparisons tend to be strengthened segmentally: stressed syllables may be emphasized by vowel lengthening or gemination, whereas stressless syllables may be weakened by reduction in vowels. Stress is governed purely by phonological factors such as distance from word edges, rhythmic factors, and syllable weight.¹⁰ The acoustic realizations of stress are affected by phonetic characteristics of stress such as positional effects, e.g., phrase-final lengthening

of both tonic and atonic syllables, down stepping and declination, i.e., an overall lowering of the pitch throughout the utterance, etc.^{9,5,4} Stress is considered as a prominent phenomenon where it refers to the prominence given to a syllable in a word or to a word in a sentence. The acoustic parameters generally considered in evaluating changes in speech characteristics are: intensity, pitch, duration, vocal tract spectrum, glottal source and vocal tract articulatory profiles²²

II. LITERATURE REVIEW

The importance of acoustic correlates of stress in these parameters i.e. fundamental frequency, intensity and duration have been studied by various researchers. While in such languages like Hindi¹⁸, Tamil¹⁹ Konkani¹², Dutch and American English²¹, Swedish and Brazilian Portuguese², English and Mandarin²⁴, fundamental frequency was a primary cue between the gender comparisons in these languages where as all the three parameters i.e. Fo, I0 and D0 had significantly difference in Dutch and American English²¹, Swedish and Brazilian Portuguese² English and Mandarin.²⁴ These results were also seen in comparison of languages such as Maithili and Marathi^{23,16}, Tamil and Hindi.^{19,18}

Nepali language is developed from Sanskrit (the cultural language).¹ A branch of the original Indo- Aryan language family and has its own phonology, grammar and vocabulary consisting of thirty-seven segmental phonemes, seven are vowels, twenty-eight are consonants, and two are semivowels and one suprasegmental phoneme.¹⁵ Although Tharu language falls under same Indo-Aryan language family, the phonology is slightly different. There are almost thirty-five phonemes, twenty-nine consonants, and six vowels. The current study aims on comparing acoustic correlates of stress in gender within and across Nepali and Tharu language.³

III. OBJECTIVES

1. To compare the stressed and unstressed parameters within males and females of both Nepali and Tharu languages.

- To compare the stressed and unstressed parameters across males and females of both Nepali and Tharu languages.

IV. RESEACRH METHODOLOGY

Twenty Nepali (10 males and 10 females) and twenty Tharu (10 males and 10 females) native speakers in age range of 18- 30 years participated in the study. All the participants were informally screened for speech, language, and hearing skills. A total of 20 stimuli, 10 Nepali phrases, and 10 Tharu phrases were used for the study where the first word in each phrase was an adjective and the second word was a noun. The appendix details on the stimuli used for the study. Participants were informed to read the two word phrases on the adjectives, with and without stress. These were audio recorded and digitized at 22 kHz sampling frequency and stored on to computer memory by using PRAAT (Version 6.0.43) software. The peak fundamental frequencies (FO), peak intensity (dB), duration (msec) were extracted from the adjectives of the 20 phrases for both stressed and unstressed conditions.

V. DATA ANALYSIS

Using independent sample t-test, Mean and Standard Deviation (SD) values for each acoustic parameter in stressed and unstressed condition were extracted. Independent sample t-test at 0.05 level of significance was also done to compare the acoustical correlates of stress in both Nepali and Tharu languages. Using SPSS (Statistical Package for Social Sciences) version 16.0, peak fundamental frequency, peak intensity and word duration were calculated.

Table 1 Comparison of gender in Nepali language using Independent sample t test

| Parameters | Males | | | | Females | | | | t-Value | Sig. (2-tailed) |
|------------|----------|--------|------------|-------|----------|-------|------------|-------|---------|-----------------|
| | Stressed | | Unstressed | | Stressed | | Unstressed | | | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | | |
| Fo | 259.35 | 101.81 | 183.57 | 48.97 | 420.31 | 71.51 | 306.46 | 54.4 | -5.802 | .008* |
| Io | 80.46 | 4.75 | 74.73 | 4.36 | 79.49 | 3.95 | 72.7 | 3.26 | 0.837 | .325 |
| Do | 0.505 | 0.094 | 0.456 | 0.103 | 0.576 | 0.114 | 0.584 | 0.126 | -2.412 | .080 |

*indicates significant at $p < 0.05$

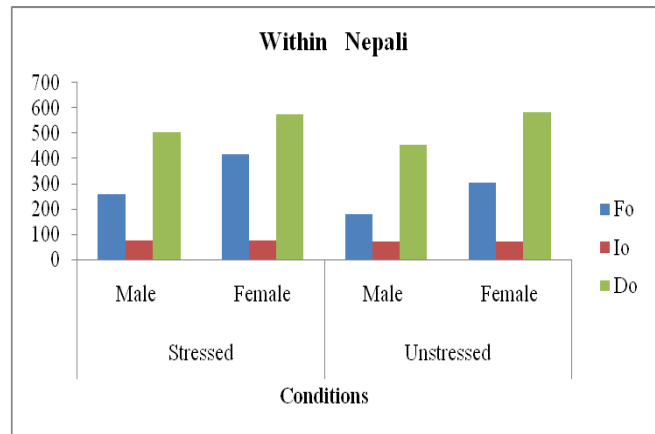


Figure 1 Comparison of gender within Nepali language

Based on the Mean and Standard deviation (SD) values, females (M=420.31 Hz, 306.46 Hz, S.D=71.5 54.4) depicted a higher peak fundamental frequency than males (259.35Hz, 183.57 Hz, S.D= 101.8, 48.9) in both stressed and unstressed conditions respectively as shown in Fig.1. It is also noted that Table 1 shows an Independent sample t-test of statistical difference within gender of males and females in Nepali language reveals statistical difference i.e., ($p=0.001$)* in both conditions. For descriptive analysis of peak intensity, males (M=80.46 dB, 74.73 dB, S.D=4.75, 4.36) had slightly higher intensity than females (M=79.49 dB, 72.7 dB, S.D= 3.95, 3.26) in both stressed and unstressed conditions respectively as shown in Fig.1. But there is no significant difference ($t=0.837$, $p=0.325$) within the gender of Nepali language in both conditions. It was also seen that females (M=576 msec, 584 msec, S.D= 114, 126) have longer word duration than males (M=505 msec, 456 msec, S.D= 94, 103) in both stressed and unstressed conditions respectively. Overall, there was no significant difference ($t= -2.411$, $p= 0.080$) within gender for Nepali language in both conditions.

Table 2 Comparison of gender in Tharu language using Independent sample t test

| Parameters | Males | | | | Females | | | | t-Value | Sig. (2-tailed) |
|------------|----------|-------|------------|-------|----------|-------|------------|-------|---------|-----------------|
| | Stressed | | Unstressed | | Stressed | | Unstressed | | | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | | |
| Fo | 139.77 | 12.73 | 136.07 | 16.69 | 243.43 | 19.46 | 236.57 | 23.04 | -12.91 | .000* |
| Io | 71.54 | 5.52 | 64.07 | 7.39 | 65.48 | 5.03 | 58.56 | 4.42 | 2.735 | .057 |
| Do | 0.951 | 0.136 | 0.924 | 0.184 | 1.001 | 0.136 | 0.985 | 0.135 | -0.901 | .402 |

*indicates significant at $p < 0.05$

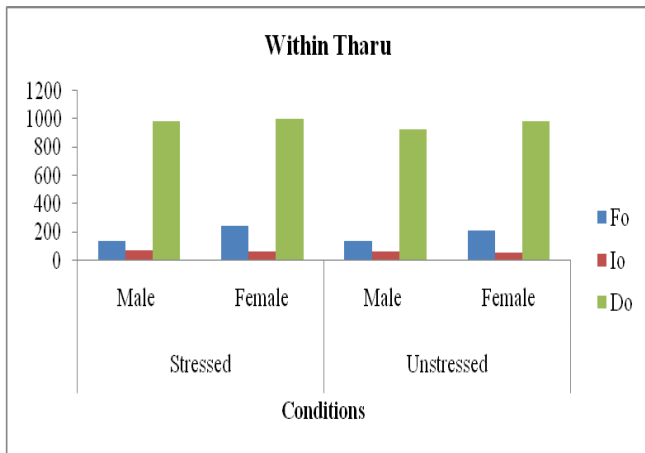


Figure 2 Comparison of gender within Tharu language

Based on the mean values, females (M=243.43 Hz, 236.57 Hz, S.D=19.46, 23.04) had a higher fundamental frequency than males (139.77 Hz, 136.07 Hz, S.D= 12.73, 16.69) in both stressed and unstressed conditions respectively as shown in Fig.2. It is also reported that Table 2 shows an Independent sample t-test of within the gender of males and females in Tharu language reveals statistical difference i.e., (t=-12.91, $p=0.000$)* in both conditions. For descriptive analysis of intensity, males (M=71.54 dB, 64.07 dB, S.D=5.52, 7.39) had a slightly greater intensity than females (M=65.48 dB, 58.56 dB, S.D= 5.03, 4.42) in both stressed and unstressed conditions respectively as shown in Fig.2. Overall, there is no significant difference (t=2.736, $p=0.057$) within gender among males and females with Tharu language in both conditions as shown in Table 2. It also reported that females (M=1001 msec, 985 msec, S.D= 136, 135) had taken longer for word duration than males (M=951 msec, 924 msec, S.D= 136, 184) in both stressed and unstressed conditions respectively. Overall, there was no significant difference (t= -0.901, $p= 0.402$) within the gender of Tharu language in both conditions.

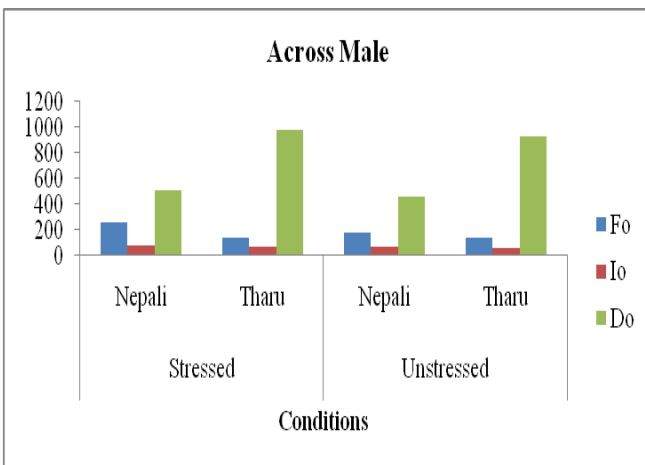


Figure 3 Comparison in males across the Nepali and Tharu languages

Table 1 and Table 2 show a comparison of gender within Nepali and Tharu languages. While comparing these tables, in gender (males) across Nepali and Tharu languages is obtained. Based on the mean values, males in Nepali language (M=259.35 Hz, 183.5 Hz, S.D= 101.8, 48.9) had the highest fundamental frequency than males in Tharu language (M=139.77 Hz, 136.07 Hz, S.D=12.73, 16.69) in both conditions as shown in Fig. 3. It is also noted that there was a significant difference ($p=0.000$ *) in fundamental frequency for males across Nepali and Tharu languages. As seen, males in Nepali language (M=80.46 dB, 74.73 dB, S.D= 4.74, 4.36) had higher peak intensity than the males in Tharu language (M=71.54 dB, 64.07 dB, S.D=5.52, 7.39) in both conditions. Results also reveal that there was a significant difference ($p=0.000$ *) in intensity for males across both languages. Based on the descriptive analysis for the duration, males in Tharu language (M=951 msec, 924 msec, S.D= 136, 184) had longer word duration than males in Nepali language (M=505 msec, 456 msec, S.D= 94, 103). As shown in Table 1 and 2, the results revealed that there was a significant difference ($p=0.000$ *) in word duration for males across both languages.

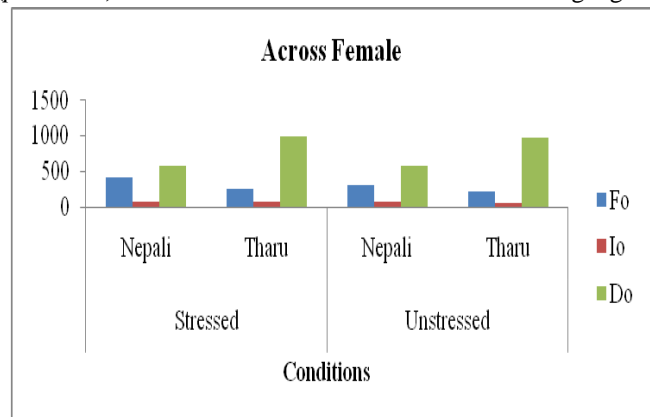


Figure 4 Comparison in females across Nepali and Tharu languages

Based on the mean values, females in Nepali language (M=420.31 Hz, 306.46 Hz, S.D= 71.5, 54.4) had the highest fundamental frequency than females in Tharu language (M=243.43 Hz, 236.57 Hz, S.D=19.46, 23.04) in both conditions as shown in Fig. 4. It is also noted that there was a significant difference ($p=0.000$ *) for fundamental frequency in females across Nepali and Tharu languages. It also reported that females in Nepali language (M=79.49 dB, 72.7 dB, S.D= 3.95, 3.26) had higher peak intensity than females in Tharu language (M=65.48 dB, 58.56 dB, S.D=5.03, 4.41) in both conditions. Results also revealed that there was a significant difference ($p=0.000$ *) in intensity for females across both languages. For duration, females in Tharu language (M=1001 msec, 985 msec, S.D=136, 135) had taken longer word duration than females in Nepali language (M=576 msec, 584 msec, S.D= 114, 126). As shown in Table 1 and 2,

the results reveal that there was a significant difference ($p=0.000^*$) in word duration for females across both languages.

VI. DISCUSSION AND INTERPRETATION

The results related several outcomes. Firstly, fundamental frequency (Fo) was significantly higher in females and intensity (Io) was significantly lower in females compared to males in both stressed and unstressed conditions. According to author²⁵, higher Fo in females can be ascribed to longer vocal folds and reduced intensity in females can also denote that the size of vocal tract and radiation area. Second, the duration taken by females was higher than males in both stressed and unstressed conditions for Nepali and Tharu languages. These findings lined with the findings on acoustic correlates in Hindi¹⁸, Konkani¹², Tamil¹⁹, Nepali¹⁷. Third, all three parameters i.e. fundamental frequency (Fo), intensity (Io), duration (Do) were significantly higher/ longer in stressed condition than unstressed condition. This finding is consonant with the findings on acoustic correlates in stress.^{7, 8, 14, 2, 19, 16} Fourth, on comparison within gender for Nepali and Tharu language, only fundamental frequency shows significant difference in both stressed and unstressed conditions, this lined with the study done on Hindi language¹⁸, Tamil¹⁹, Konkani¹². Fifth, on comparison across gender for Nepali and Tharu language, all three parameters i.e. Fo, Io and Do shows significant difference in both conditions. This is in line with the reports of previous researchers.^{21, 2, 24} These results were also reported in comparing languages such as Maithili and Marathi^{23, 16}, Tamil and Hindi.^{19, 18}

VII. CONCLUSION

This study focused on comparing the acoustic correlates of stress in gender across and within Nepali and Tharu languages. The results revealed that fundamental frequency was only primary cue to differentiate within gender for Nepali and Tharu language. But for comparison of gender across Nepali and Tharu language, all three parameters i.e. Fo, Do and Io show significant difference. This study showed that females have a higher fundamental frequency than males and also reveals female speakers' focuses more on pitch and word duration whereas male speakers only on loudness for stress word. The present study is an attempt to contribute to the information on gender comparison for Indo-Aryan languages. But due to lack of studies done on gender comparison between Indo-Aryan languages, the current study cannot further show the reason behind the results. A further more study has to be done on acoustic correlates of stress for gender comparison across the different languages.

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