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Production and Perception of Lexical Tones in Manipuri Language

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ABSTRACT

There is a discrepancy in the established number of lexical tones in Manipuri, a tonal language, as well as the terminology used to describe them. Hence, the present study attempts to describe the characteristics of lexical tones in monosyllabic and bisyllabic words in Manipuri using acoustical analysis and it perception by eight native speakers. Minimal pair words contrasting in tone were recorded from three native speakers of Manipuri. Pitch values extracted for each word were used to identify different tone contours based on the configuration of the pitch contour, initial pitch and final pitch. Results revealed four pitch contours namely, level, falling, rising and falling-rising in monosyllabic words. First syllable of the bisyllabic words revealed level-high and level-low contours. The second syllable showed level, rising and falling contours. In addition, individual differences were noticed in the pitch contours obtained for the same word across speakers. However, for each speaker, each minimal word pair were always distinguishable using pitch contour, initial pitch and final pitch of the pitch contour. The meaning of all the words was identified correctly above chance level by native speakers. It is possible that normalization of the lexical tones produced by different speakers was done by the listeners.

Keywords: Lexical tones, Manipuri language, acoustical analysis, speech perception

1. INTRODUCTION

Suprasegmental features of speech include variations in fundamental frequency, amplitude and duration. Certain languages of the world make use of variations in fundamental frequency or pitch to distinguish meaning of the words which have same segmental features. These languages which make use of phonologically contrastive variations in pitch at the word or syllable level are called tonal languages. Some of the tonal languages which have large number of native speakers are Mandarin, Canotonese and Thai. Among Indian languages Manipuri is one such tonal language belonging to Kuki-Chin group of the Tiebeto-Burman sub-family, spoken predominantly in Manipur, a North-eastern state of India (Chelliah 1997; Singh 2000; Singh 1975).

The number of lexical tones and its characteristics are well described in major tonal languages of the world. For example, Mandarin has four contrastive tones namely high level, high rising, low falling-rising, and high falling tones (Chao 1948; Howie 1976; Moore & Jongman 1997). Cantonese has six lexical tones namely, high level, high rising, mid level, low falling, low rising, and low level (Whitehill & Ciocca 2000). Thai has five lexical tones. However, till date, the number of lexical tones is not well characterized in Manipuri language. There is inconsistency in the identified number of contrastive tones in Manipuri, as well as the terminology used to describe them. Previous researchers have identified two to six tones in Manipuri language (Chelliah 1992, 1997; Radhakrishnan & Savithri 2005; Singh 1975; Singh 2000).

Singh (1975) reported that Manipuri language shows a three way tonal contrast namely, falling, rising, and level. However, this identification of tones was not based on acoustical analysis. Chelliah (1992, 1997) suggested that low and high are the two tones in Manipuri language. Chelliah (1992, 1997) analyzed minimal tone pairs produced by a native Manipuri adult male speaker. Based on the differences in the initial pitch of the word obtained by pitch tracking, existence of low and high tones was shown. Pitch contour was not given as much importance as that

given to the initial pitch. Singh (2000) also reported of two tones in Manipuri. However, they were named as level and rising tones. Additional description of these tones is not available.

Further, Radhakrishnan & Savithri (2005) recognized six tones in Manipuri and labeled them as rising, falling, level, rising-falling, falling-rising, and rising-falling-rising tones. Minimal tone pairs spoken by an adult female who was native speaker of Manipuri was used for the acoustical analysis. Highest Fo, lowest Fo, transition of tone, transition duration and speed of transition of each tone was measured. In addition, perceptual discrimination scores of Manipuri minimal tone contrast words by native speakers of Manipuri ranged from 87% to 100% with an average of 97.5%.

Investigators who performed acoustical analysis of Manipuri tones (Chelliah 1992, 1997; Radhakrishnan & Savithri 2005) have studied only single speaker data. Acoustic data from more than one native speaker of Manipuri might better characterize the tones in Manipuri. Also perceptual identification of minimal tone contrast words by native speakers of Manipuri has not been studied. Investigating the identification of lexical tonal pairs is required to supplement the information obtained from acoustical analysis of lexical tones. In addition, acoustical analysis of tones might also aid in describing the perception of tones by native speakers. The present study characterize Manipuri tones in both monosyllabic and bisyllabic words using acoustical analysis. It also assess the perception of these stimuli by native speakers of Manipuri.

2. METHOD

2.1. *Participants*

A total of 11 native speakers of Manipuri (nine females and two males) participated in the study. Among them three individuals (two females and one male) produced the words used for acoustic analysis and perception experiment. Eight individuals participated in the perception experiment. The participants ranged in age from 21 to 25 years. All the participants had air conduction hearing thresholds within 15 dB HL at octave

frequencies between 250 Hz to 8000 Hz. All participants had normal functioning middle ear indicated by "A" type tympanogram with ipsilateral acoustic reflex thresholds present within 90 dB HL for octave frequencies between 500 Hz to 2000 Hz. None of the participants reported any otological and/or neurological problems.

2.2. *Acoustical analysis*

2.2.1. *Material*

Seven minimal pairs of monosyllabic words and nine minimal pairs of bisyllabic words contrasting in tone were selected from Singh (2000). These 16 pairs forming 32 words in total were recorded from three native speakers (S1, S2, & S3) of Manipuri language. They were required to say each word with particular meaning. All the words were spoken by each speaker in isolation. Three iterations of each word were recorded using a unidirectional microphone using Praat software (Boersma & Weenink 2012) at a sampling frequency of 44,100 Hz, quantization level set at 16 bit and was stored to a personal computer. All the recording was done in a sound treated room.

2.2.2. *Procedure*

Acoustical analysis was carried out using Praat software. Fundamental frequency values were extracted at 1 ms interval for each word using autocorrelation. In order to compare the pitch contours across the words, the duration of each word was normalized by transforming the unit of time from millisecond to percentage (Howie 1976). Thus, fundamental frequency values were plotted in graph against time (in percentage) at 10% interval for each word and for each speaker separately to obtain pitch contours. Thus obtained pitch contours were used to characterize the lexical tones in Manipuri language.

2.3. *Perception experiment*

2.3.1. *Stimuli*

Material recorded from speaker S1 was used for the perception experiment. One word was selected from three iterations of each word, thus forming 32 words. One picture was selected for each

of the 32 words of these 16 minimal pairs which depicted its meaning.

2.3.2. *Procedure*

To investigate the perception of these minimal tonal pairs by native speakers of Manipuri, identification of the meaning of the recorded words were done. For this, the pictures and the recorded words were incorporated in DMDX software (Forster & Foster 2004). During each trial, two pictures appeared simultaneously on the computer screen along with one auditory word. One picture corresponded to the meaning of the target word and the other corresponded to the minimal pair counterpart of the target word. The participants were required to press the key corresponding to the target picture on hearing the auditory word. All the auditory words were less than 600 ms in duration. However, in each trial, the pictures lasted for 3000 ms. There were 160 trials presented to each participant with each word appearing 5 times. The words were presented in random order using scrambling code of DMDX. The auditory stimuli were presented binaurally through headphones at comfortable listening levels. Percent correct identification scores were calculated for each listener.

3. Results and Discussion

3.1. *Acoustical analysis*

3.1.1. *Monosyllables*

Figure 1 (a-n) shows the fundamental frequency contours of speaker S1 obtained for monosyllabic words from three iterations. From the Figure 1 (a-n) it is clear that fundamental frequency contour did not vary across three iterations. Therefore, fundamental frequency patterns were averaged across three iterations to describe the lexical pitch contours.

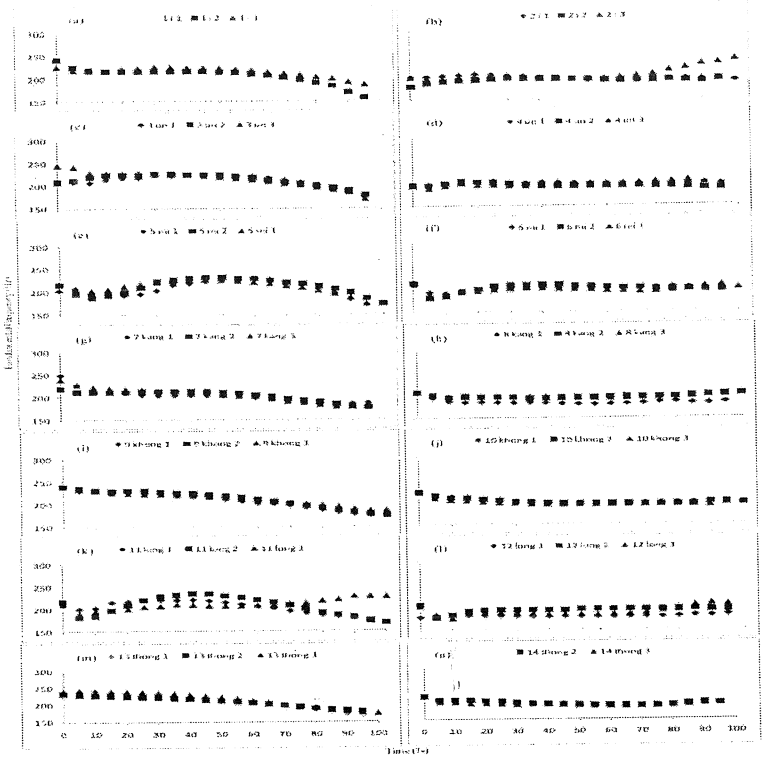

Figure 1. *Fundamental frequency contours obtained for each of the monosyllabic word in three iterations (from panel 'a' to 'n') for speaker S1.*

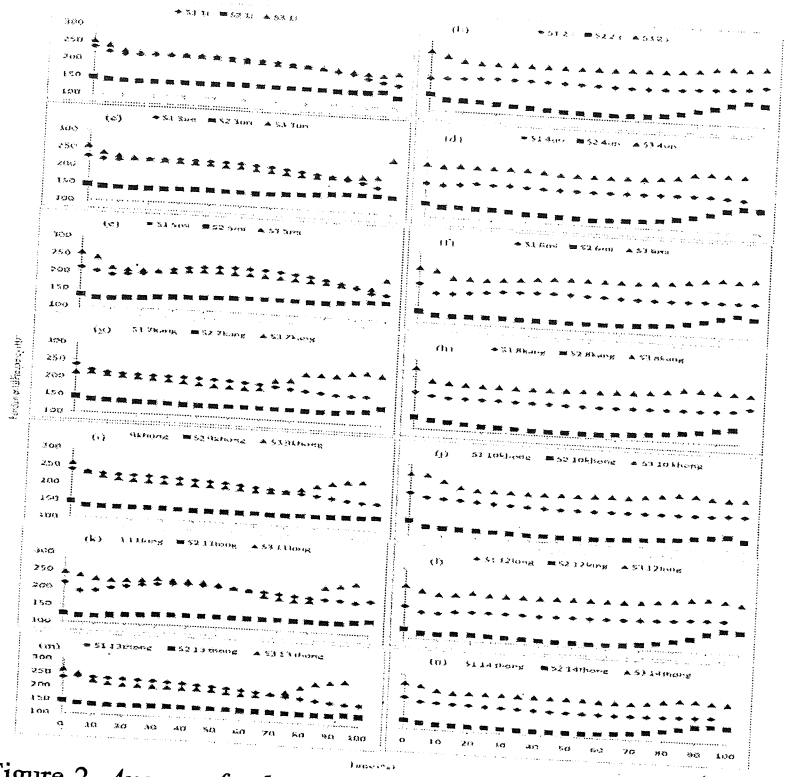

Figure 2. *Average fundamental frequency contours obtained for each of the monosyllabic word (from panel 'a' to 'n'), for each speaker (S1, S2 and S3).*

Table 1. *Different pitch contours obtained for different monosyllabic Manipuri words spoken by three native speakers of Manipuri. (S1-Speaker1, S2-Speaker 2, S3-Speaker 3, L-level, F-falling, R- rising, FR- falling-rising)*

S. No	Manipuri Word	Meaning in English	S1	S2	S3
1	I	Blood	F	L	F
2	I	Thatch	R	FR	R
3	Un	Skin	F	L	F
4	Un	Ice	L	FR	FR
5	Mi	People	F	R	F
6	Mi	Spider	L	FR	R
7	Kang	Mosquito	F	L	FR
8	Kang	A game	L	FR	R
9	Khong	Leg	F	L	FR
10	Khong	Stream	L	FR	L
11	Long	Spear	F	L	FR
12	Long	Fishing net	L	FR	L
13	Thong	Door	F	L	FR
14	Thong	Bridge	L	R	L

Figure 2 (a-n) shows averaged (across three iterations) lexical pitch contours for three participants separately for each monosyllabic word. Table 1 shows the tone contour that was obtained for each word. From Figure 2 and Table 1, it can be seen that speaker S1 produced three tone contours namely falling (7 words), rising (1 word) and level (6 words) tones. However, S2 had falling-rising (6 words), rising (2 words) and level (6 words) tones. Whereas, S3 produced falling-rising (5 words), rising (3 words), falling (3 words) and level (3 words) tones.

3.1.2. *Bisyllabic words*

Figure 3 (a-r) shows the pitch contours obtained for S1 from bisyllabic words in three repetitions. From Figure 3 it can be seen that in bisyllable words tone contours were different for first and second syllable of the word. Therefore, tone contours for the first and second syllable were described separately. The pitch pattern for the first syllable of all the words had level contour. However, it was found that the fundamental frequency value for one word of the minimal pair was relatively high or low than the other word of the pair. For example, for word *kaba* with meaning "to climb," the average fundamental frequency for first syllable /ka/ was 206 Hz but for the same word with meaning "over fry," the average fundamental frequency was 172 Hz in speaker S1. Hence, these tones were described as level-high or level-low. The pitch pattern of the second syllables showed level, rising or falling contours. As observed in monosyllable the fundamental frequency contour did not vary across three iterations.

Figure 4 (a-r) shows averaged pitch contours obtained for bisyllabic words for three speakers. Table 2 shows the tone contours obtained for each of the bisyllabic words. From Figure 4

and Table 2 it can be observed that, for S1 in the first syllable, level-high and level-low contours were obtained in 9 words each. In the second syllable, level, rising or falling contours were obtained in 11, 5 and 2 words respectively. For the first syllable of bisyllabic words, both S2 and S3 had level-high and level-low tones in 9 words each respectively. In the second syllable S2 produced level (10 words) and rising (8 words) tones, whereas S3 produced level (13 words) and falling tones (5 words).

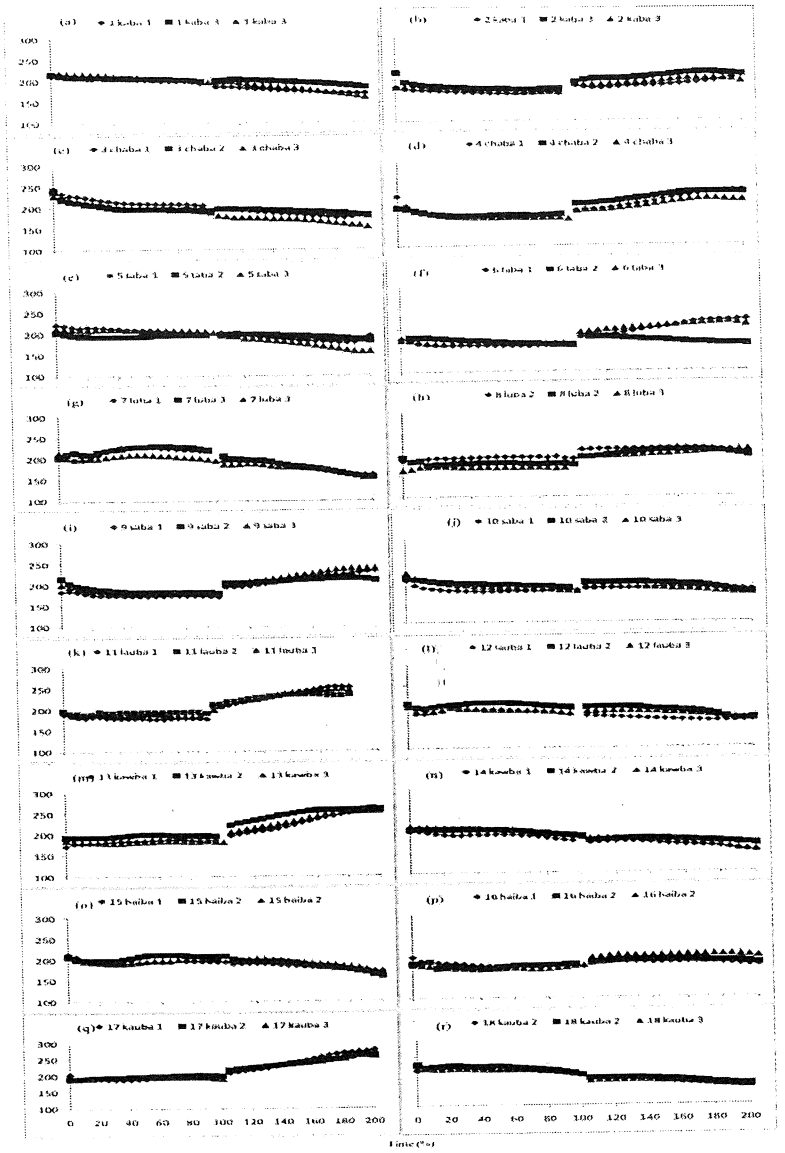

Figure 3. *Fundamental frequency contours obtained for each of the bisyllabic word in three iterations (from panel "a" to "r"), for speaker S1.*

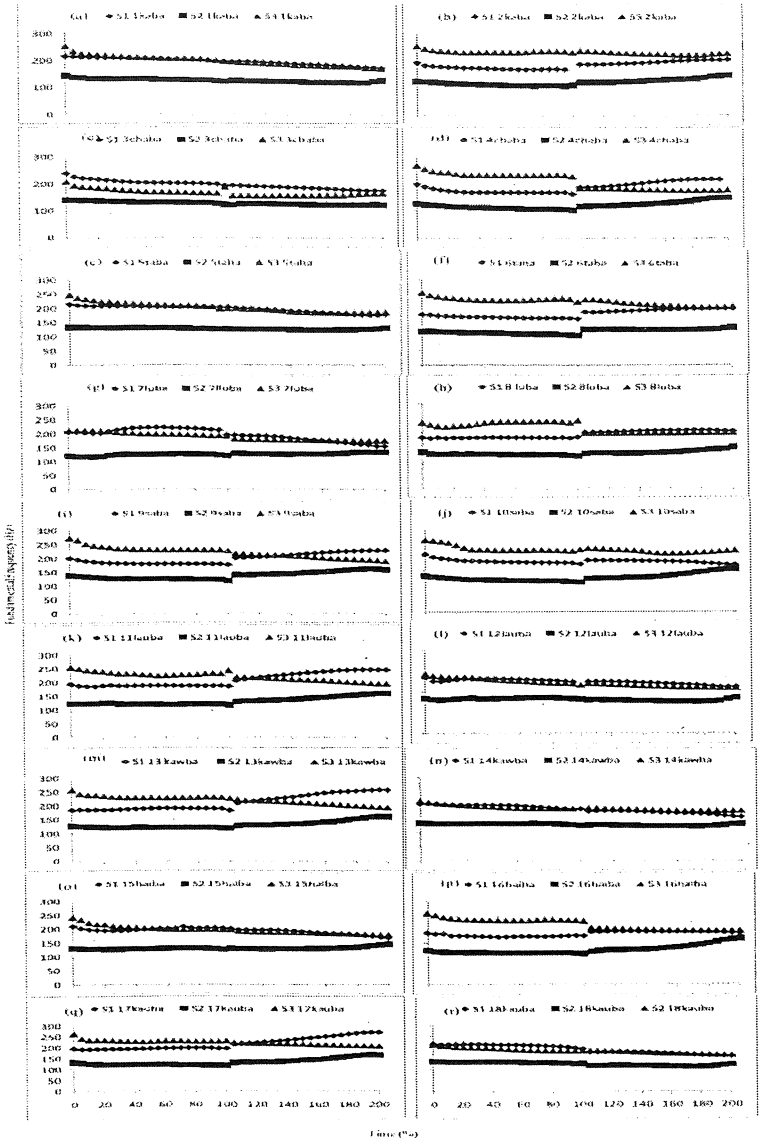

Figure 4. *Average fundamental frequency contours obtained for each of the bisyllabic word (from panel "a" to "r"), for each speaker (S1, S2 and S3).*

Table 2. *Different pitch contours obtained for different bisyllabic Manipuri words spoken by three native speakers of Manipuri. (S1-Speaker1, S2-Speaker 2, S3-Speaker 3, L(H)-Level-high, L(L)-Level-low, L-level, F-falling, R-rising)*

			S1		S2		S3	
S. No	**Manipuri word**	**Meaning in English**	**First syllable**	**Second syllable**	**First syllable**	**Second syllable**	**First syllable**	**Second syllable**
1	kaba	To climb	L(H)	F	L(H)	L	L(L)	F
2	kaba	Over fry	L(L)	L	L(L)	R	L(H)	L
3	chaba	To eat	L(H)	L	L(H)	L	L(L)	L
4	chaba	To hang around	L(L)	R	L(L)	R	L(H)	L
5	taba	To hear	L(H)	F	L(H)	L	L(L)	L
6	taba	To fall	L(L)	L	L(L)	L	L(H)	F
7	luba	Clear	L(H)	F	L(H)	L	L(L)	L
8	luba	Difficult question	L(L)	L	L(L)	L	L(H)	L
9	saba	To make	L	R	L(H)	R	L(H)	F
10	saba	Hot	L	L	L(L)	R	L(L)	L
11	lauba	To shout	L(L)	R	L(L)	R	L(H)	F
12	lauba	Large hole	L(H)	L	L(H)	L	L(L)	L
13	kawba	To forget	L(L)	R	L(L)	R	L(H)	F
14	kawba	To kick	L(H)	L	L(H)	L	L(L)	L
15	haiba	To say	L(L)	F	L(L)	L	L(H)	L
16	haiba	To swing	L(H)	L	L(H)	R	L(L)	L
17	kauba	To call	L(L)	R	L(L)	R	L(H)	L
18	kauba	Short	L(H)	L	L(H)	L	L(L)	L

Acoustic analysis revealed that Manipuri language showed four types of tonal contrasts namely falling, rising, level and falling-rising in monosyllabic words. In bisyllabic words, the first syllable showed level-high and level-low contours, whereas the second syllable showed level, rising and falling contours. There was relatively high stability of occurrence of same contours within a participant across different iterations. However, across different speakers there was high degree of variability. For example, for monosyllable word *khong* with meaning "leg," S1 showed falling, S2 showed level and S3 showed falling-rising tones. Similar observation can also be made in bisyllabic words. Variability in the production of lexical tones across different

speakers is also reported other languages as well. Lee and Hung (2008) reported that there was variability among the Mandarin speakers though the fundamental frequency contours were consistent with descriptions of Mandarin tones. The observed variations in the pitch contours in the present study may also be due to dialect variations among speakers. Manipuri dialect spoken by three speakers was slightly different from one another.

3.2. *Perception experiment*

Results of the perception experiment revealed that the percent correct identification score of words contrasting in tones ranged from 68.12% to 88.75% with mean identification score of 79.76%. Percent correct identification score for individual participants is shown in Figure 5. Figure 6 (a and b) shows the percent correct identification score obtained for each monosyllabic and bisyllabic words respectively. The percent correct identification score for monosyllabic words ranged from 27.5% to 97.5% and for bisyllabic words, the range was between 42.5% and 100%. It can also be observed that except two words, all words were identified correctly well above chance level (chance identification is 50%).

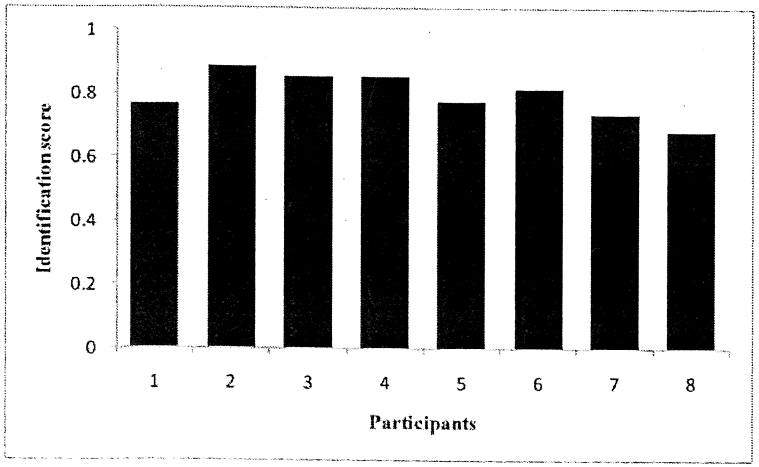

Figure 5. *Overall correct identification score for each of the participant*

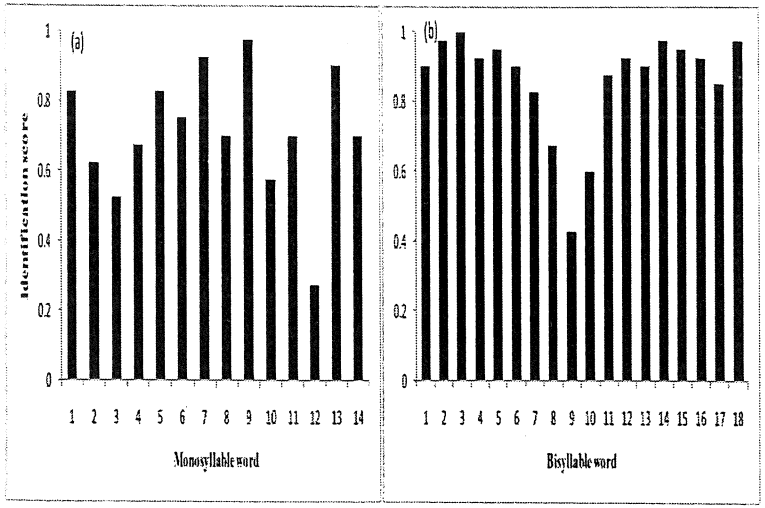

Figure 6 (a). *Identification score for each of the monosyllabic words from all the listeners.* (b). *Identification score for each of the bisyllabic words from all the listeners.*

It is interesting to find that though the pitch contours were different for most of the words spoken by three speakers, native listeners could identify the meaning well above chance level. These results suggest that invariant acoustic cue (pitch contour) is not essential for the perception of lexical pitch. It is possible that the listeners did normalization of the lexical tones produced by different speakers. It should also be noticed that in each minimal pairs, all the three speakers produced the words with distinguishing pitch contour. This contrasting pitch could have helped the listeners to identify the meaning of the word.

4. CONCLUSIONS

Present study attempted to characterize the production and perception of lexical tones in Manipuri language. It was found that four pitch contours were reliably identified in monosyllabic words. Level-high and level-low contours were found in the first syllable of the bisyllabic words and three contours in the second syllable. Three to four pitch contours were identified in each

speaker. Though pitch contours produced by each speaker was different, listeners could normalize the lexical tones and could correctly identify the meaning of the word well above chance level.

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