KOYEE VOWELS: AN ACOUSTIC ANALYSIS

TARA MANI RAI

This paper focuses on the acoustic analysis of Koyee basic vowels. Koyee exhibits basically six vowels. In the acoustic analysis of the basic vowel sounds in the Koyee language, the first formant (F2) are identified as the acoustic analysis cues and they are measured both male and female Koyee speakers individually and in average. The average of F1 and F2 was plotted in F1 versus F2 plane and later compared them plotting them in the same acoustic vowel space. The study shows that female acoustic vowel space is slightly larger than the male. This is because of the differences of the vocal tract of female and male. Although the exact formant frequency values of the vowels produced by male and female speakers varied, the ratio of the difference of the formant frequency values of the different vowels is similar for both male and female speakers. Further, the female voice is more conservative than those of the male speakers because the males are very often in contact with other language speakers.

***Key words**: Acoustic, formants, frequency*

1. Introduction

Koyee is one of the Rai Kirati languages of the Himalayish sub-group within Tibeto-Burman group of Sino-Tibetan language family (Eppele et al. 2012: 57). The term 'Koyee' refers to the people as well as the language they speak. This language is considered to be closer to the neighboring languages, namely, Dumi and Khaling (Hanβon 1991: 45-46). Although the Koyee language is mainly spoken in Sungdel and Rawa Dipsung VDCs in Khotang district, it is also spoken in some other places of Jhapa, Morang, Sunsari, and Kathmandu districts by the migrated Koyee speakers (Rai and Budhathoki 2008: 1-2).

Koyee is one of the pre-literate, endangered and least studied languages of Nepal. The latest Census gives the number of mother tongue speakers as 1,271 which is 0.0054 percent of the total population 26,494,504 (CBS 2012). But the distribution of the speakers recorded in the Census 2012 is not reliable which needs more exploration. No dialects are traced out in Koyee language[1]. However, Hanßon (1991: 46) notes that there are two dialects: Sungdel and Behere (Byare). In this paper, we have tried our best to analyze the basic Koyee vowels from the acoustic perspective.

This paper is organized into four sections. The first section is the background of the study. In section 2, we deal with the methodology that consists of the method of data collection and the sample of the speakers. Section 3 discusses the analysis of the data. Section 4 summarizes the findings of the paper.

[1]Toba et al (2002) has informed that Koyee has no dialects at all.

2. Methodology

2.1 Method of data collection

The utterances of the speakers were recorded using Sony ECM-MS908c Electret Condenser Microphone and EDROL, R09HR audio recorder maintaining the environment as required.

The formant frequencies of the basic vowels in Koyee have been measured from Koyee male and female speakers. The average formant frequency values for both male and female have been computed in *k-k* context. The target words for three formants (F1- F3) are given in the example (1).

(1)	a.	[i]	*/kiki/*	'maternal uncle'
	b.	[e]	*/keki/*	'non word'
	c.	[ʌ]	*/kʌki/*	'know.1PL.incl. PST '
	d.	[u]	*/kuku/*	'maternal uncle'
	e.	[o]	*/kok (tsam)/*	'known'
	f.	[a]	*/kaku/*	'filter'

2.2 The speakers[2]

The data were collected from the four fluent Koyee speakers for the experimentation of how Koyee vowels are uttered. The speakers were included from different age groups and gender as can be seen in Table 1.

Table 1: List of the speakers

	Age group	Gender	
1.	21-31	Male	JK, AK
2.	31-41	Female	MK, NK

Male speakers were from the age group 21-31 and female from the age group 31-41.

3. Analysis of data

The recorded data were edited using Audacity, an audio editing software and were analyzed using PRAAT, (a software program for analyzing speech sounds in phonetics). The techniques used in this paper are based on Ladefoged (2003).

The relevant acoustic cues for the vowels are the formant frequency values, which indicate the prominent resonances of the vocal tract. O'connor (1997: 57) says, ' vowels

[2]The data were collected from the Koyee speakers: Archan Koyee Rai (21), Jaya Raj Koyee Rai (31), Mila Koyee Rai (31), Menuka Koyee Rai (41) from Sungdel Village of Development committee in Khotang district. They were monolingual when they were children. They can speak Nepali, English besides their mother tongue. They still use their language in day to day communication if they meet the people from their community.

generally have more than three formants (e.g., F4, F5) but these higher formants don't seem to be needed for specifying vowels and are more connected with identifying the voice quality of the particular speaker'. Thus, the first two formants of the vowels are important acoustic cues since the change in the vowel quality is accompanied by the corresponding changes in the formant frequencies.

Formants are the resonances of the vocal tract. The most vivid display of the formants is in the spectrogram. In the spectrogram, the horizontal axis represents the time in seconds and vertical axis represents the frequency in hertz (Bordon & Harris 1980).

The formant frequency of six vowels of the Koyee language sampling from male and female is presented in Table 1.

Table 1: Individual and average formant frequency values in Koyee vowels (from male speakers)

Formant frequency (in Hz)		V O W E L S					
F1		***i***	***e***	***ʌ***	***a***	***o***	***u***
	Jay Raj	284	589	503	700	415	343
	Archan	328	444	574	697	422	372
	Average	306	517	539	699	419	357
F2	Jay Raj	2355	1700	962	1162	987	933
	Archan	2488	2213	1569	1575	1010	967
	Average	2421	1956	1265	1370	999	950
F3	Jay Raj	3436	2966	1985	2544	2757	2947
	Archan	2751	2686	2534	2429	2526	2473
	Average	3093	2826	2259	2486	2641	2710

Table 1 shows that F1 decreases as the tongue height is increased. F1 is inversely proportional to the tongue height. F2 is found to have been decreased from the front vowels to the back vowels. It has the highest value for the vowel *[i]* and the lowest for [u]. This shows that F2 is associated with the backness of the tongue body. F2 is directly proportional to the articulatory parameter of backness. F3 appears to be the highest for the vowel *[i]* and the lowest for *[a]*. F3 does not show much information about the quality of the vowels as does F1 or F2 as it is changed as sound quality changes.

The frequency values of the formants in Table 1 are shown in the stylized figure 1.

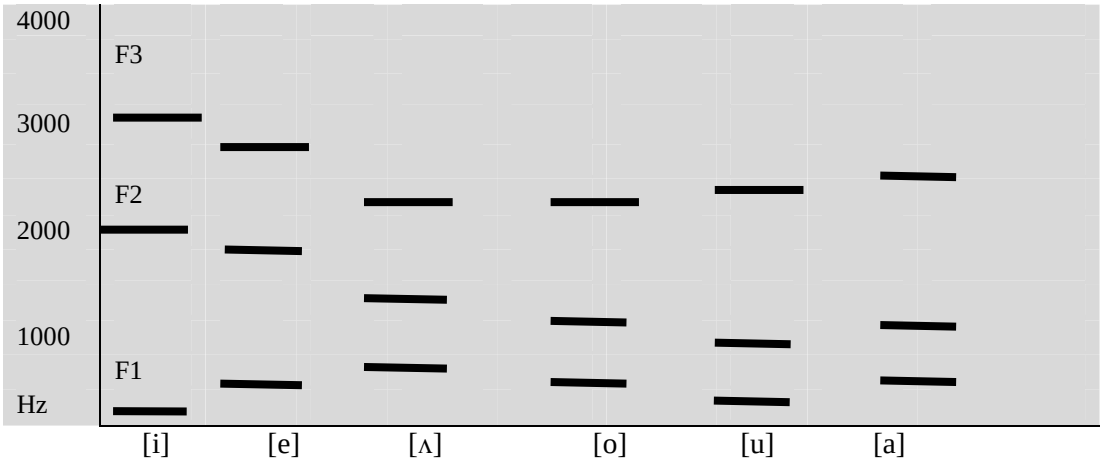


Figure 1: Average and stylized formant frequencies (F1-F3) of the pure vowels of the Koyee language by male speakers

Figure 1 presents average and stylized formant frequencies (F1-F3) of the pure vowels of the Koyee language by male speakers.

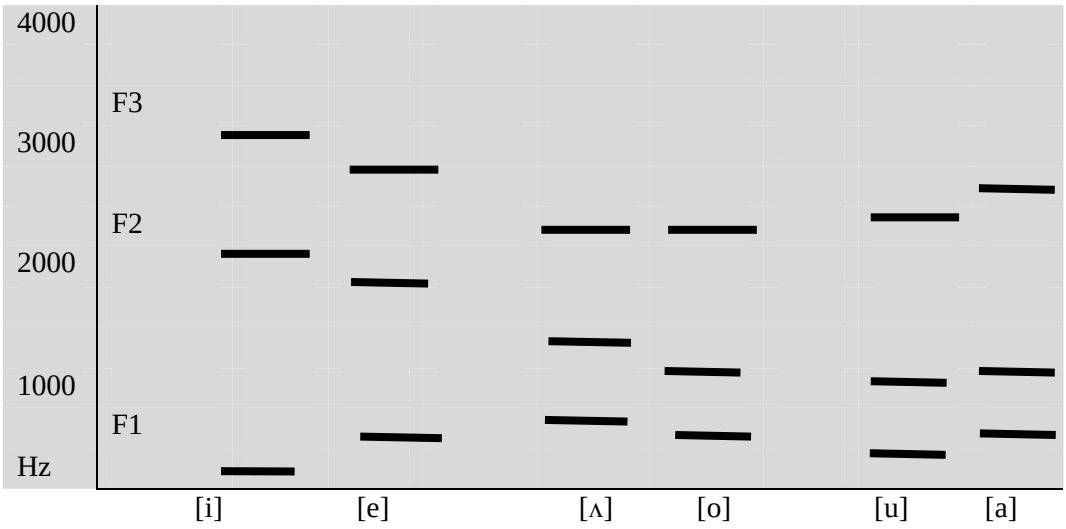
Table 2: Individual and average formant frequency values in the Koyee vowels (from female speakers)

Formant frequency (in Hz)		V O W E L S					
F1		*i*	*e*	*ʌ*	*a*	*o*	*u*
	Mila	322	485	597	827	485	425
	Menuka	316	549	724	797	497	318
	Average	319	517	660	812	491	371
F2	Mila	2411	2111	1363	1562	1025	778
	Menuka	2378	1839	1350	1383	1019	1027
	Average	2394	1975	1357	1472	1019	902
F3	Mila	3241	3031	3237	3162	2970	2842
	Menuka	3301	3215	3063	1790	3112	3037
	Average	3271	3123	3150	2447	3041	2939

Table 2 shows the formant frequencies (F1- F3) of female Koyee speakers. As we move from the front vowels to the back vowels, the second formant value is continuously decreasing. It means that F2 is the highest for the vowel *[i]* while it is lower for the vowel

[u]. So F2 corresponds to the articulatory parameter of backness of the tongue body. In the same way, F1 is lower of the high vowels and higher for the low vowels.

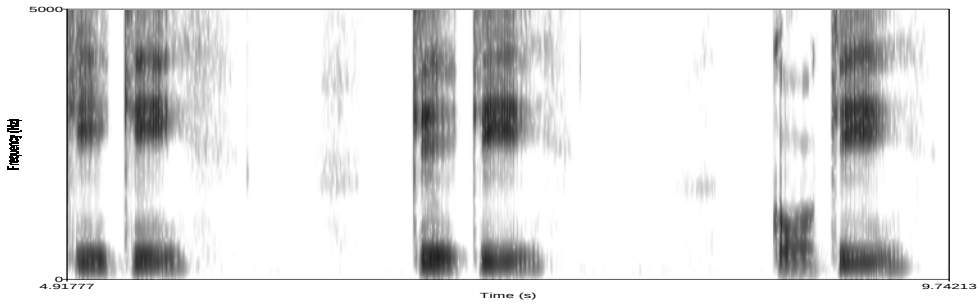
Figure 2 presents average and stylized formant frequencies (F1-F3) of the basic vowels of the Koyee language by female speakers.



As can be seen in the above Tables 1 and 2, the F1 and F2 values for male and female are comparable in many ways. The slightly higher F1 of *[i]* sound for female than for the male is accompanied by all other vowels except [u] and [i].

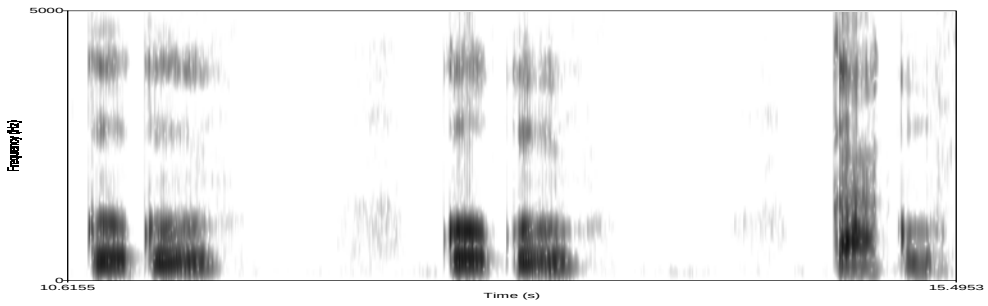
4. Sample of spectrograms

The sample of spectrograms with formant counter for each of the vowels in Koyee is presented in figure 2-3.



[i] [e] [ʌ]

Figure 2: Average formant frequencies (F1-F3) of the pure vowels of female speakers



[u] [o] [a]

Figure 3: A spectrogram of the words as given in the examples (20)

Figure 4 presents the formant chart of the first formant on the ordinate (the vertical axis) plotted against the distance between the frequencies of the first and the second formants on the abscissa (the horizontal axis) for six Koyee vowels by Koyee male speakers.

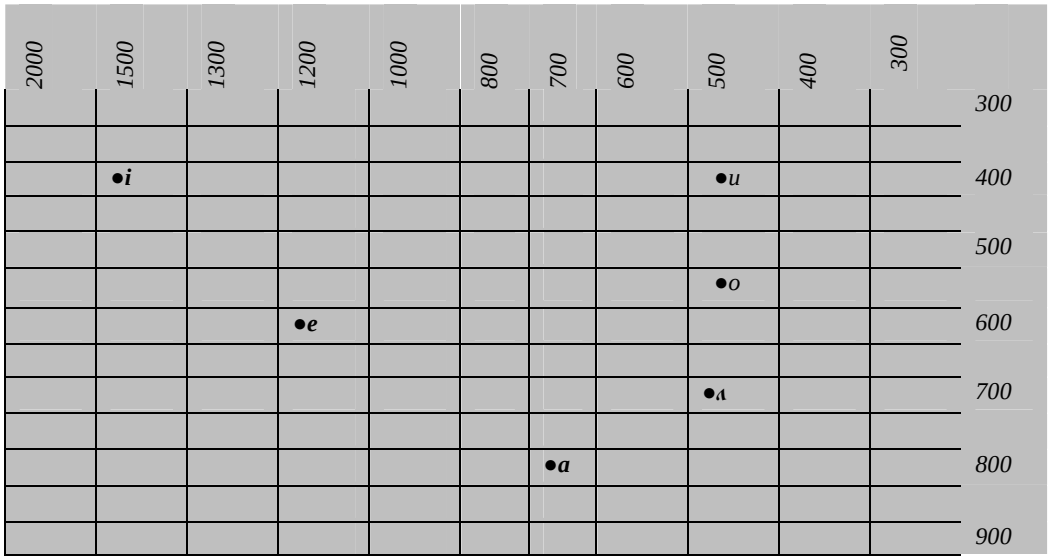


Figure 4: A formant chart showing the frequency of the first formant and second formant for six Koyee vowels by Koyee male speakers

Figure 4 shows the formant chart of the first formant on the ordinate (the vertical axis) plotted against the distance between the frequencies of the first and second formants on the abscissa (the horizontal axis) for six Koyee vowels by the Koyee male speakers.

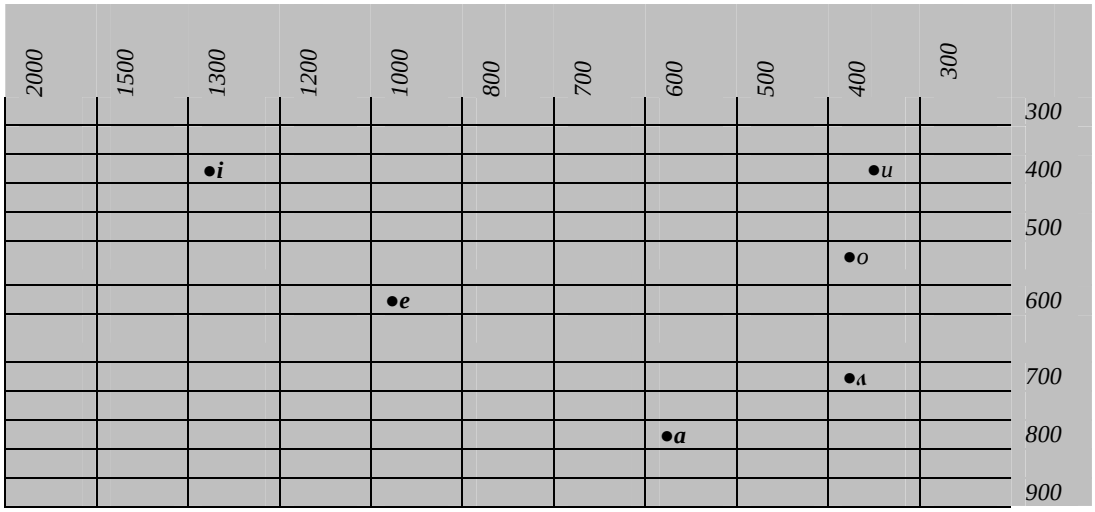


Figure 5: A formant chart of the first formant and second for six Koyee vowels by female Koyee speakers

Figure 5 presents average formant frequency values of the Koyee vowels spoken by male speakers (connected lines) and female speakers (dotted lines) which are presented below.

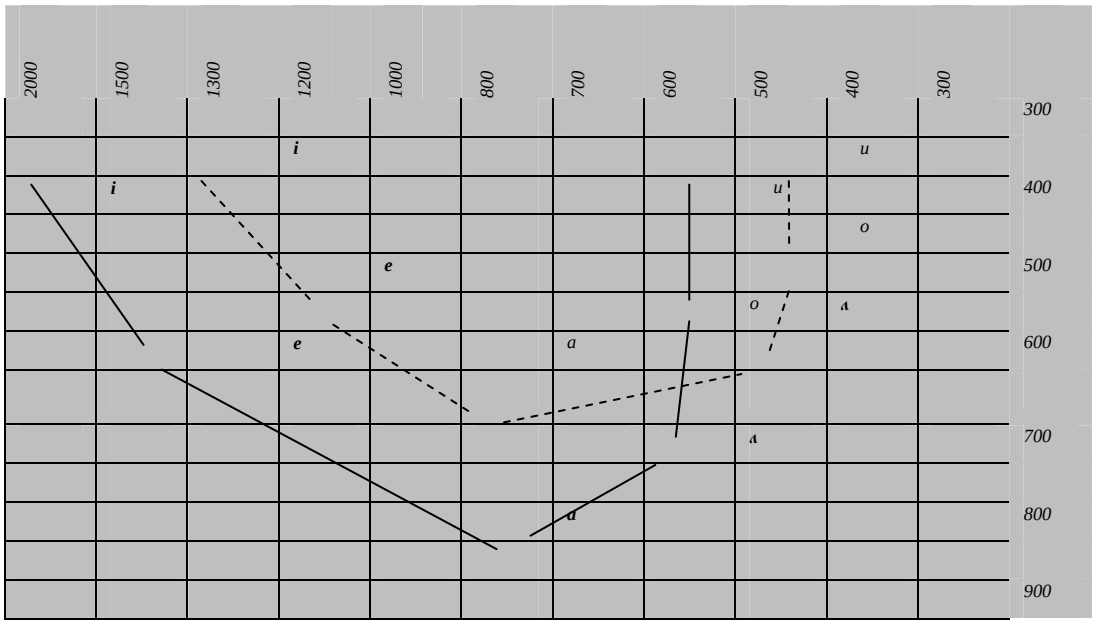


Figure 6: Average formant frequency values of Koyee vowels spoken by male speakers (connected lines) and female speakers (dotted lines

Figure 6 shows the acoustics of male and female speakers. The space of females seems to be smaller than those of male speakers. This is because resonance of frequency of female vocal tract is relatively higher than the resonance frequency of male vocal tract.

4. Conclusion

Koyee exhibits basically six vowels. In the acoustic analysis of the basic vowel sounds in the Koyee language, the first formant (F2) are identified as the acoustic analysis cues and they are measured both male and female Koyee speakers individually and in average. The average of F1 and F2 was plotted in F1 versus F2 plane and later compared them plotting them in the same acoustic vowel space. The study shows that female acoustic vowel space is slightly larger than the male. This is because of the differences of the vocal tract of female and male. Although the exact formant frequency values of the vowels produced by male and female speakers varied, the ratio of the difference of the formant frequency values of the different vowels is similar for both male and female speakers. Further, the female voice is more conservative than those of the male speakers because the males are very often in contact with other language speakers.

References

Bordon, Gloria J & Katherine S. Harris.1980. *Speech science primer: Psychology, acoustics and perception of speech.* Baltimore: The Williams and Wilkins Company.

Central Bureau of Statistics. 2012. *National population and housing Census 2011: National report.* Kathmandu: Central Bureau of Statistics.

Eppele, John W., M. Paul Lewis, Dan Raj Regmi and Yogendra P. Yadava. eds. 2012. *Ethnologue: Languages of Nepal*. Kathmandu: Linguistic Survey of Nepal (LinSuN).

Hanβon, Gerd .1991. *The Rai of Eastern Nepal: Ethnic and linguistic grouping: Findings of the linguistic survey of Nepal;* Werner Winter ed. Kathmandu: LSN and CNAS.

Ladefoged, Peter.1975. *A course in phonetics.* USA. Harcourt Brace Jovanovich, Inc.

Rai, Tara Mani and Mohan B. Budhathoki. 2008. *A documentation of Koyee language.* A report submitted to the National Foundation of Indigenous Nationalities (NFDIN).

Toba, Sueyoshi, Ingrid Toba and Novel Kishore Rai. 2005. *Diversity and endangerment of languages in Nepal.* Kathmandu: UNESCO.