A CASE STUDY ON COMPARISON OF MALE AND FEMALE VOWEL FORMANTS BY NATIVE SPEAKERS OF KOREAN

Takako Igeta & Takayuki Arai

Graduate School of Science and Technology, Sophia University, Tokyo, Japan
t-igeta@sophia.ac.jp; arai@sophia.ac.jp

ABSTRACT

Compared to the amount of research on Korean consonants, few studies indeed have been done to analyze Korean vowels. In addition, the results of recent studies are mixed. This study was conducted for reviewing the Korean vowel system.

In this study, we measured the formant frequencies of eight Korean vowels by three Seoul dialect female speakers of Korean in their early 30s, and compared the results with those of two Korean males in their early 30s. We confirmed overlapped /e, ɛ/, /u, o/ and /a, ɔ/ formant frequencies uttered by female speakers, this was also the result of male speakers. These findings were similar to the results in the previous studies. Additionally vowel spaces of males have corresponded to the results indicated in previous studies. However the vowel spaces of females were different from the results of previous studies.

Keywords: Korean, vowel system, formant measurement, Seoul dialect

1. INTRODUCTION

The Korean vowel system is discussed by phoneticians in Korean and other countries. However, studies of Korean vowel system have not received much attention; compared to the amount of research done on consonants, few studies have been done to analyze vowels. Therefore even the total number of vowels is still being discussed. One reason is that The National Institute of the Korean Language published "Method of standard pronunciation" (in Korean) in 1988. In that method, ten vowels /a, i, ɯ, u, e, ɛ, ɔ, o, wi, we/ were confirmed as monophthongs, and both /wi/ and /we/ were admitted as diphthongs too [6]. The total number of monophthongs differs according to each phonetician [9]. Also in Cho [1], though there are some prescribed monophthongs in Korean, the total number of monophthongs vary from seven to ten according to each phonetician. In fact, each phonetician has a different claim. Production experiments by Cho [1] on ten vowels were published from The National Institute of the Korean Language for Seoul dialect speakers. The results revealed that two vowels are diphthongs and eight vowels are monophthongs.

The most famous study result is undisposed /e/ and /ɛ/ in Korean monophthong. In studies by Chung [2] and Umeda [11], Seoul dialect speakers had no way of distinguishing /e/ and /ɛ/ in a perception experiment; Cho [1] and Moon [8] also obtained the same result by production experiment. Thus, the study of Korean monophthongs had focused on /e/ and /ɛ/ in the past.

In recent studies, vowel spaces are paid attention to, including other monophtongs [1, 8], but each side reveals a different result. In the study by Cho [1], the tongue position in vowels /a/ is more front than /ɔ/ by males. In a study of Moon [8], /u/ and /o/ overlapped each other. However, the common results are just /e/ and /ɛ/; results for other vowels are not overlapping results. Igeta, et al. [3] revealed subsequently overlapped /u/ and /o/ by males, as is the case with Moon [8]. As we mentioned before, these results did not correspond except for /e/ and /ɛ/.

Thus, we conducted measuring formant frequencies (F1, F2) for a few Seoul dialect speakers. Although we needed many participants for accurate data, we accorded priority to the conditions of participants (age, sex) rather than the quantitative number. The purpose of this study is a comparison of values of formant frequencies (F1, F2) between male [3] and female as a case study.

2. RESEARCH METHOD

The utterances of eight Korean vowels by native speakers of Seoul dialect were recorded.

2.1. Participants

Three female native speakers of Seoul dialect (KFS1, KFS2, KFS3) took part in this study. They have lived in Seoul or Gyeonggi-do area near Seoul city from birth to 15 years of age, and they were 31 years old at that time. They were all

graduate students in Japan, and they were able to converse fluently with native speakers of Japanese.

2.2. Recorded sounds

Among the 110 nonsense words recorded by native speakers of Seoul dialect, eight were monophthongs /a, i, ɯ, u, e, ɛ, ɔ, o/, and 80 were combinations of ten Korean consonants /b, d, g, p, t, k, s, tɕ, dʑ, ɾ/ (excluding nasal consonants and tense consonants), and 8 vowels. Twenty-two additional /V/ and /CV/ including /u, o/ were also recorded. These 110 nonsense words were repeated three times by each participant; a total of 330 utterances were recorded. However our targets were only V (/a, i, ɯ, u, e, ɛ, ɔ, o/) in this study.

2.3. Procedure

First, the nonsense words were presented one by one on the computer screen, and the utterances were recorded. We manipulated the computer manually when we showed the next nonsense words on the computer screen to the participants. The reasons were to avoid any immixing of other noise by the participants' movement and to enable the participants to concentrate on their utterances.

The recordings took place in a sound-proof room (background noise level: 23.3dBA), using a digital sound recorder (Marantz PMD 660) and a microphone (SONY ECM-23F5) at a sampling frequency of 48 kHz and a quantization level of 16 bit.

3. ANALYSIS

Our targets were only V (/a, i, ɯ, u, e, ɛ, ɔ, o /); we measured the vowel formant frequencies by using XKL [5]. Some preparation was necessary before using XKL. First, these utterances were down sampled from 48 kHz to 8 kHz, and the file format was converted from wav to xkl on Linux. Then, we measured three points of first and second formant frequencies (F1, F2) in the steady state of each vowel. We adopted estimated values of formant frequency by linear prediction analysis in XKL. Additionally, we confirmed it by visual checks.

We calculated the distance between origin (0, 0) and each point (F1, F2) on a plane surface of F1-F2 based on the obtained value of F1 and F2 for each of the three points in each vowel. The F1 and F2 pairs that give the median values in the three distances were adopted as the measures of central tendency in each vowel. Finally, we calculated the two-dimensional normal distribution on F1 and F2 values on each vowel, and we plotted iso-probabillity ellipses in such a way that $\mu \pm 3\sigma$ (μ: average, σ: standard deviation).

4. RESULTS AND DISCUSSION

4.1. Value of F1 and F2

Table 1 presents average F1 and F2 by Seoul dialect male and female speakers in their 30s. Some data of F1 and F2 of males were taken from Igeta [3].

Table 1: Average F1 and F2 by Seoul dialect male and female speakers in their early 30s.

Target	F1 [Hz]		F2 [Hz]	
	male	female	male	female
/a/	803	887	1175	1358
/i/	217	238	2318	2980
/ɯ/	284	468	1549	1787
/u/	268	356	876	1065
/e/	482	592	2064	2518
/ɛ/	484	663	2067	2517
/ɔ/	590	707	857	1138
/o/	373	444	666	743

4.2. Individual data

First, we discussed individual data; after that, we presented results of the plotted vowel space for female speakers. Especially we focused on three vowel pairs: /e, ɛ/, /u, o/ and /a, ɔ/.

4.2.1. In the case of KFS1

Figure 1 indicates the vowel space of KFS1. In the case of KFS1, /e, ɛ/ overlapped completely with [1, 3, 8], and /a, ɔ/ overlapped, too. The iso-probability ellipse of /a, ɔ/ overlapped on F2. The reason is the difference of front-back of tongue. This result corresponded to [3]; however, /u, o/ did not overlap, so this result did not correspond to [3, 8].

4.2.2. In the case of KFS2

Figure 2 shows the vowel space of KFS2. In the case of KFS2, the /e, ɛ/ overlapped; thus the result is identical with [1, 3, 8], but the shape of the iso-probability ellipse of /e/ is very long and thin. The reason is that the difference of height of tongue put in an appearance at value of F1.

4.2.3. In the case of KFS3

Figure 3 shows the result of the vowel space of KFS3. In the case of KFS3, /e, ɛ/ overlapped on F1.

Figure 1: Vowel space of KFS1.

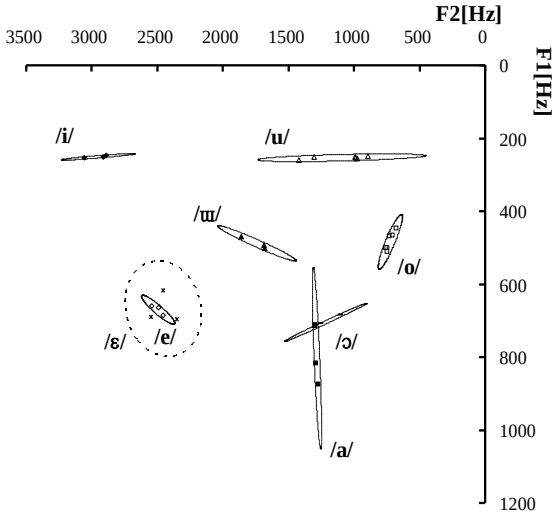


Figure 2: Vowel space of KFS2.

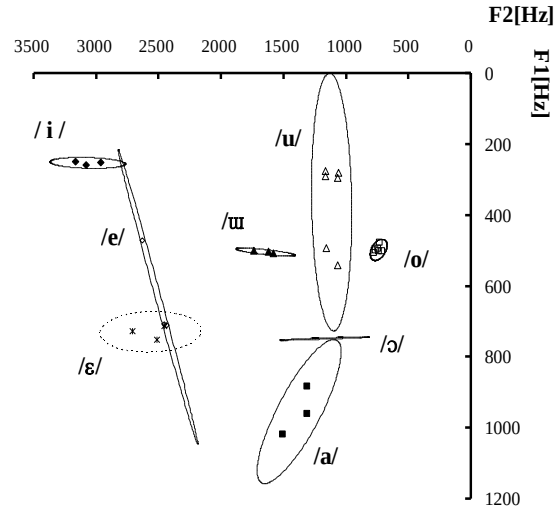
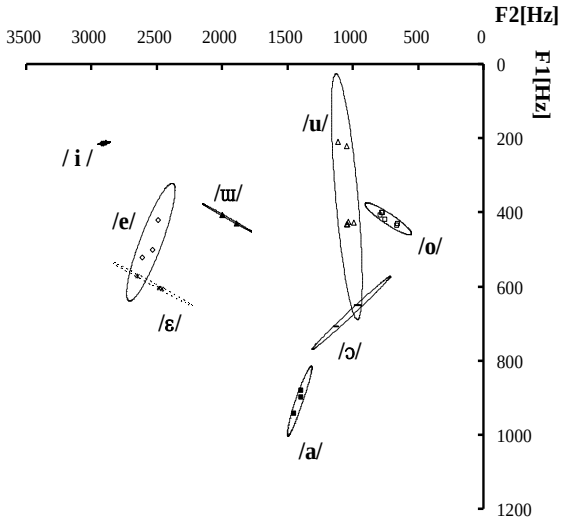


Figure 3: Vowel space of KFS3.



The shape of the iso-probability ellipse of /ɛ/ is very thin, because the shape was related to the front-back position of the tongue. However, /u, o/, /a, ɔ/ did not overlap.

4.3. Comparing female and male

The results are shown in Figure 4 and Figure 5. Figure 4 illustrates the vowel space of Seoul dialect female speakers in their 30s, and Figure 5 is males' (Igeta [3]) data.

Figure 4: Vowel space of Seoul dialect female speakers in their early 30s.

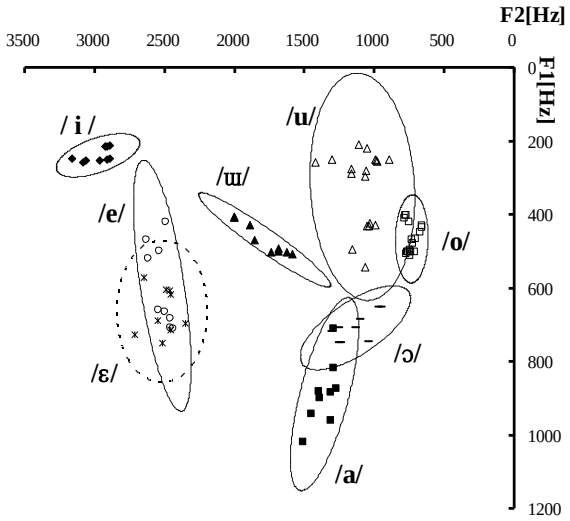
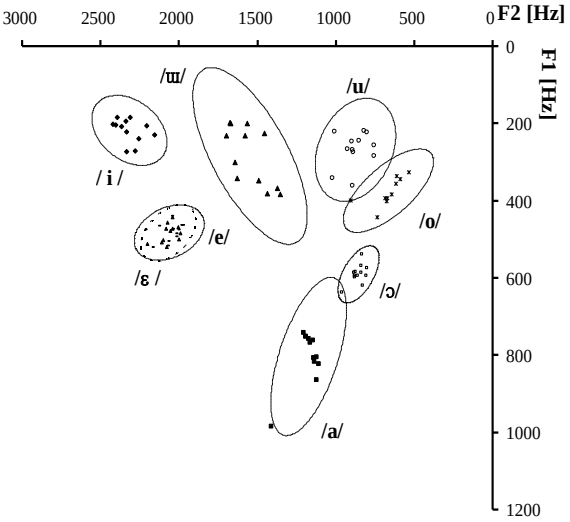


Figure 5: Vowel space of Seoul dialect male speakers in their early 30s.



In Figure 4, /e, ɛ/ nearly overlapped. The /u, o/ overlapped on F1, and /a, ɔ/ overlapped on F2. The iso-probability ellipse of /u, o/ indicates a difference of the height of tongue; that of /a, ɔ/ is related to the front-back position of the tongue.

In Figure 5, /e/ and /ɛ/ overlapped. The result in the present study is consistent with the finding of [1, 3, 8], and /u, o/, /a, ɔ/ overlapped. The result of /u, o/ and /a, ɔ/ corresponded with [3, 8]. We confirmed overlapping of the same vowel pairs: /e, ɛ/, /u, o/ and /a, ɔ/ comparing Figure 4 and 5.

4.4. Summary of results

We organized overlapped vowel spaces based on review studies [1, 3, 8]. Table 2 gives a summary. This study revealed that vowel space of males have corresponded with the results indicated in the previous studies. However those of females were different from the results of previous studies.

Table 2 shows the individual differences that appeared in the result; these covered the results of the previous study totally.

Table 2: Overlapped monophthongs based on the results of individuals.

	/e, ɛ/	/u, o/	/a, ɔ/	overlapped others
KFS1	overlapped	—	overlapped	—
KFS2	overlapped	—	—	/i, e/
KFS3	overlapped	—	—	/u, ɔ/
Female	overlapped	overlapped	overlapped	/u, ɔ/
Male	overlapped	overlapped	overlapped	—

5. CONCLUSION

There were basically two results on vowel space. The vowel space of female is larger than male space; however, individual data did not perfectly correspond to the previous studies. The result of overlapped /a, ɔ/ corresponded to Igeta [3]; this result was revealed for the first time there. The results in the present study were consistent with the finding of Igeta [3].

Because of a potential of other overlapped cases for when there were differences between individuals, we need to research native speakers of Seoul dialect living in Korea in the near future. Furthermore, the three vowel pairs overlapped on the iso-probabillity ellipse; however, we have to investigate the overlapping data.

6. ACKNOWLEDGMENTS

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