

L1 and Gender Effects in Korean Learners' Production of English /s/*

Misun Seo
Hannam University

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This study investigated the influence of L1 allophonic rule, L1 segment articulation, and gender in Korean learners' production of English /s/ in two different contexts (i.e., before a high front vowel vs. elsewhere) and at three different proficiency levels in English (i.e., low vs. intermediate vs. high). The influence of the Korean allophonic rule realizing /s/ as [ʃ] before a high front vowel was not attested. The low and intermediate groups did not exhibit any significant difference between English /s/ before a high front vowel and English /s/ elsewhere regarding centroid frequency (CF). This result illustrates that the low and intermediate groups did not differentiate the articulation of English /s/ in the two contexts regarding its place of articulation. In addition, the high group illustrated a significantly higher CF for English /s/ before a high front vowel than for English /s/ elsewhere, illustrating that the high group pronounced English /s/ before a high front vowel in a more front region of a vocal tract. All the three groups of Korean learners showed significantly higher CF for English /s/ occurring in the context elsewhere in comparison to the native English group, and this may have been due to the influence of an alveo-dental or dental articulation of Korean /s/ (Lee, 1996; Sohn, 1996). Finally, gender effects were attested in the production of English /s/. Male Korean groups at three different proficiency levels in English showed significantly higher CF and PAF (Peak Amplitude Frequency) than the male native English group when pronouncing English /s/ while there was no significant difference among the female groups. It is required to examine whether an alveo-dental or dental articulation of Korean /s/ is more frequently observed in males' speech than in females' in order to say that the result of English /s/ in this study occurred due to the influence of the articulation of Korean /s/.

Keywords: English /s/, centroid frequency (CF), peak amplitude frequency (PAF), L2 sound production

1 Introduction

L2 sound production has been said to be influenced by various factors of L1. First of all, it has been argued that different phonological systems of L1 and

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L2 play a role in L2 production. Thus, L2 speakers have difficulty pronouncing two L2 sounds which are not contrastive in their L1. For example, Korean and Japanese learners of English have difficulty pronouncing correctly English [ɹ] and [l] since the two sounds are not contrastive in their L1 (Aoyama, Flege, Guion, Akahand-Yamada, & Yamada, 2004; Best & Strange, 1992; Borden, Gerber, & Milsark, 1983; McClelland, Thomas, McCandliss, & Fiez, 1999).

In addition, different allophonic patterns of L1 and L2 occurring due to different phonological rules of L1 and L2 can trigger difficulty in L2 sound production. According to Seo, Kim, Shin, and Kim (2005), Korean learners of English tended to pronounce a stop before a nasal as a nasal when they pronounced English words with a stop plus nasal sequence due to the influence of the phonological rule in Korean changing a stop into a nasal before a nasal, as in /pap + mul/ → [pammul] 'ricewater' (Shin & Cha, 2004).

This study aims to investigate the production of the English fricative /s/ by Korean learners of English having different proficiency levels in English, focusing on its place of articulation. Korean learners' pronunciation of English /s/ is an interesting topic to examine the influence of L1 on L2 sound production considering an allophonic rule of the Korean /s/ and individual variation for a place of articulation of /s/.

2 Literature Review

Korean is different from English in that there is no contrast between /s/ and /ʃ/. In Korean, /s/ occurs as a phoneme and there is a phonological rule realizing /s/ as [ʃ] before a high front vowel /i/.

(1) Realization of /s/ in Korean (Bergmann, Hall, & Ross, 2007; Sohn, 1999)

a. before /i/

| | | |
|----------|----------|----------------|
| /misiŋ/ | [miʃiŋ] | 'superstition' |
| /osiŋ/ | [oʃiŋ] | 'fifty' |
| /kasi/ | [kaʃi] | 'thorn' |
| /sikiŋe/ | [ʃikiŋe] | 'watch, clock' |

b. elsewhere

| | | |
|---------|---------|--------------|
| /miso/ | [miso] | 'smile' |
| /kasu/ | [kasu] | 'singer' |
| /sal/ | [sal] | 'flesh' |
| /kasəl/ | [kasəl] | 'hypothesis' |

As can be seen from the examples in (1a), Korean /s/ is palatalized before /i/ and surfaces as [ʃ] while /s/ is realized as [s] elsewhere.

Korean /s/ is classified as an alveolar consonant in most previous studies (Cho, 1990; Hume, 1992; Kim-Renaud, 1974; Lee, 1995; Shin, 2003;

Shin & Cha, 2004 among others). On the other hand, Sohn (1999) defines Korean /s/ as an alveo-dental consonant with other Korean consonants /t, t^h, t', s', n, l/ by describing that the consonants are "produced with the top (not the tip) of the tongue touching or approaching the back of the upper teeth and the gum-ridge area with the tongue tip touching the back of the lower teeth (p. 153)." Moreover, Lee (1996) argues that individual variation can occur when Koreans produce Korean /s, s'/ by pronouncing them as either alveolars or dentals.

Given the allophonic variation of Korean /s/, it is expected that with the interference of L1, Korean learners of English will have difficulty pronouncing English /s/ as [s] before a high front vowel. They will pronounce English /s/ as [ʃ] before a high front vowel if they cannot suppress the application of the Korean phonological rule when they pronounce the sequence of /s/ plus a high front vowel. Such a tendency will be influenced by Korean learners' proficiency levels in English. It can be predicted that the tendency will be more apparent in the low English proficiency group and less apparent in the high English proficiency group. This study aims to investigate the production pattern of English /s/ before a high front vowel and that of English /s/ elsewhere by Korean learners at different proficiency levels in English.

According to Lee (1996)'s claim that Korean /s/ can be pronounced as an alveolar or dental consonant depending on individuals, it is expected that Korean learners' pronunciation of English /s/ will vary depending on how they pronounce Korean /s/. According to Kong, Kang, and Seo (2014), gender differences were observed in the pronunciation of Korean word-medial affricates: females produced them in a more anterior region of a vocal tract than males. Provided this, this study also examines the influence of Korean learners' gender in the realization of a place of articulation of English /s/ by comparing Korean learners' production of English /s/ to native English speakers' within each gender group.

In this study, the following research questions will be examined:

- 1) How is the articulation of English /s/ before /i/ different from that of English /s/ elsewhere according to Korean learners' proficiency levels in English?
- 2) Is there any gender difference when Korean learners pronounce English /s/ in different contexts?

3 Research Methodology

3.1 Participants

30 Korean learners of English, who were university students in Seoul or Daejeon participated in the production experiment. Among them, 10 (5 males, 5 females) had TOEIC scores of 500s or below and were grouped as low in

English proficiency. Another 10 with TOEIC scores of 700's were grouped as intermediate in English proficiency and the other 10 with TOEIC scores of 900's as high. Speech of four native speakers of English (2 males, 2 females) from Canada was also recorded for base-line data of native English speakers. At the time of recording, they had length of residence in Korea for 6.3 years on average.

3.2 Materials

The materials employed in the production experiment were 17 words with the target sound /s/ in word initial, medial, or final position. A full list of the words used in the experiment are shown in Table 1 below.

Table 1. Words for the Production Experiment

| Initial | Medial | Final |
|---------|-------------|---------|
| cell | messing | furnace |
| sack | sensory | mess |
| sip | accomplices | plus |
| suit | | peace |
| sane | | piss |
| sat | | stress |
| sin | | |
| sue | | |

3.3 Procedure and analysis

To elicit natural speech, each of the words in Table 1 was put in a carrier sentence "please say _____". In the production experiment, each participant read a list of sentences containing target words which were displayed to each participant in a randomized order. A sentence with a target word was recorded three times since three sets of sentences with target words were made by shuffling sentences before each time of the recording. Of the three recordings, the last one was acoustically analyzed. Recordings were made in a quiet room with a head-mounted microphone (Audio-Technica M8531) and a TASCAM HD-P2 recorder. The digitization setting used was 44,100 Hz sampling rate and 16 bit quantization. By the production experiment, 578 tokens (17 words × 34 speakers) were obtained.

Centroid frequency (CF) and peak amplitude frequency (PAF) of the target fricative /s/ in each token was measured around the midpoint of the fricative noise of /s/ by using the *Praat* program. CF indicates the centroid of the fricative noise, i.e. the center of gravity of a defined part of the spectrum, each frequency being weighted according to its amplitude (Cho, Jun, & Ladefoged, 2002; Forrest, Weismer, Milenkovic, & Dougall, 1988; Jones & Munhall, 2003). In addition, PAF is the frequency of the spectral peak with the highest amplitude (Chang, Haynes, Yao, & Rhodes, 2009). Both CF and PAF

are acoustic indices showing a place of articulation of a fricative. CF and PAF are inversely correlated with the length of the front cavity. Thus, a more fronted place of articulation, which is produced with a shorter front cavity, has higher CF and PAF (Behrens & Blumstein, 1988; Jongman, Wayland, & Wong, 2000; Ladefoged, 2005; Nittrouer, Studdert-Kennedy, & McGowan, 1989; Shadle, 1985).

4 Results

With 578 tokens collected from 30 Korean learners of English and 4 native English speakers, a multivariate analysis of variance (MANOVA) was conducted. In the analysis, CF and PAF were dependent variables and independent variables were participants' group (low vs. intermediate vs. high vs. native), position of the target segment /s/ (word-initial vs. word-medial vs. word-final), and the context in which English /s/ occurs (before a high front vowel (i.e., /i/ or /ɪ/) vs. elsewhere).

According to the analysis, a significant main effect of group was found with CF ($df = 3, F = 3.186, p < .05$). Figure 1 illustrates the finding.

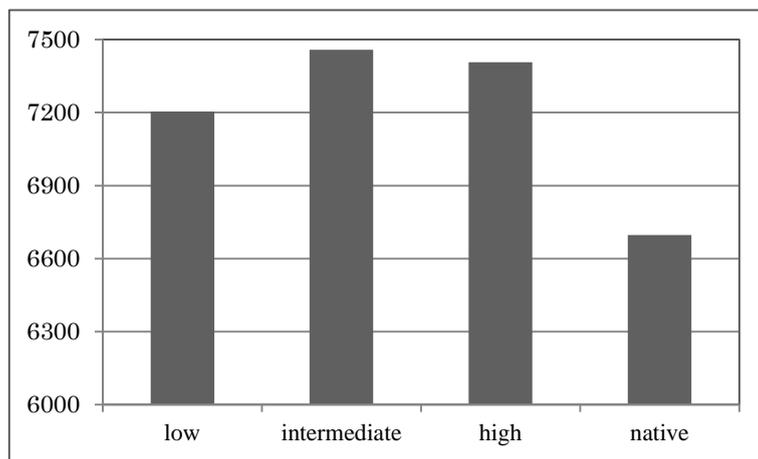


Figure 1. Mean CF of /s/ by group

As illustrated in Figure 1, CF of /s/ was the highest in the intermediate at 7457.5 Hz (standard deviation = 1722.6 Hz) followed by the high at 7406.4 Hz (standard deviation = 1411.5 Hz), the low at 7204.2 Hz (standard deviation = 1539.5 Hz) and the native at 6697 Hz (standard deviation = 1403.5 Hz). A post-hoc test of LSD showed significant differences for low vs. native, intermediate vs. native, and high vs. native ($p < .05$). Thus, each of the three groups of Korean learners exhibited a significantly higher CF of /s/ than the

native English group. With PAF, there was no significant main effect of group ($df = 3, F = 2.057, p = .105$).

According to a MANOVA, a significant main effect of position was also found with PAF ($df = 2, F = 3.309, p < .05$). The finding is illustrated in Figure 2.

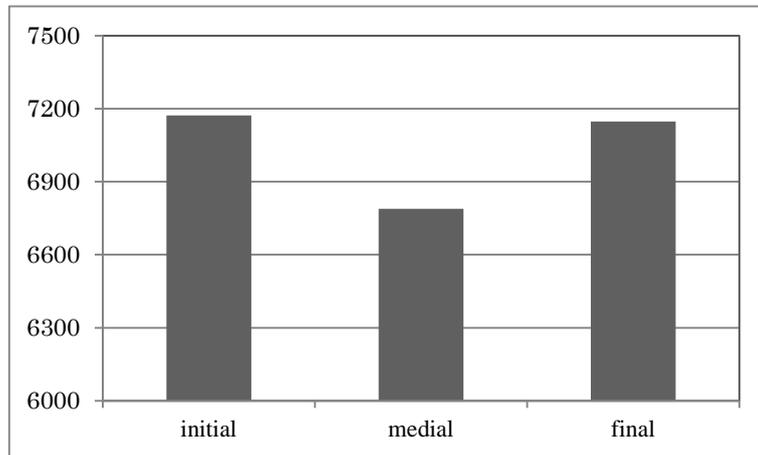


Figure 2. Mean PAF of /s/ by position

As can be seen from Figure 2, PAF of /s/ was the highest in word-initial position at 7172.6 Hz (standard deviation = 2416.3 Hz) followed by in word-final position at 7146.7 Hz (standard deviation = 2166.1 Hz) and in word-medial position at 6788.9 Hz (standard deviation = 2281.6 Hz). However, there was no significant main effect of position with CF of /s/ ($df = 2, F = 2.094, p = .124$).

In addition, a significant main effect of context was found with PAF of /s/ ($F = 5.846, p < .05$). PAF of /s/ was significantly higher when /s/ occurs before a high front vowel (i.e., /i/ or /ɪ/) than when it occurs elsewhere (7257.6 Hz vs. 7045.9 Hz) (standard deviation = 2539 Hz vs. 2232.2 Hz). On the other hand, no significant main effect was attested with CF of /s/ ($F = 2.105, p = .147$). There was a significant interaction of group * context with CF of /s/ ($df = 3, F = 2.670, p < .05$). Figure 3 shows the finding.

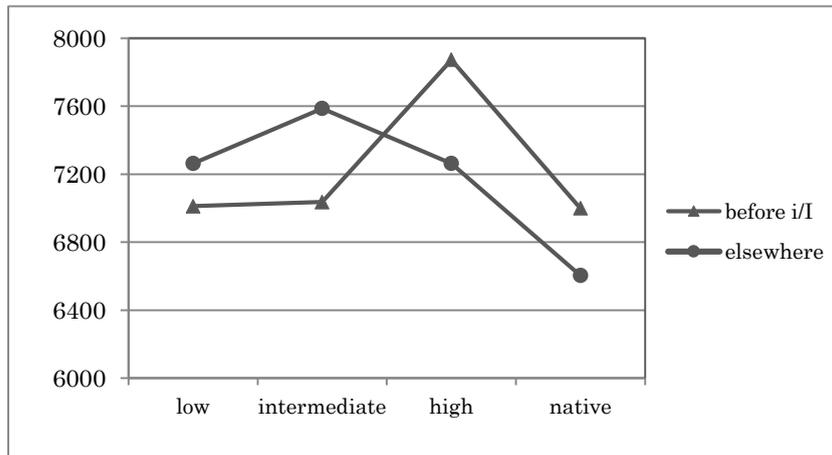


Figure 3. Mean CF of /s/ by group * context

As can be seen from Figure 3, CF of /s/ before a high front vowel /i/ or /ɪ/ was the highest in the high group at 7873.4 Hz (standard deviation = 1596.6 Hz) followed by the intermediate at 7036.5 Hz (standard deviation = 2099.9 Hz), the low at 7011.6 Hz (standard deviation = 1543.1 Hz), and the native at 6999.1 Hz (standard deviation = 1695.2 Hz). An analysis of variance (ANOVA) was run to see whether CF of /s/ before a high front vowel was significantly different among the four groups, and there was no significant main effect of group ($df = 3$, $F = 2.224$, $p = .088$). However, according to a post-hoc test of LSD, significant differences were attested for low vs. high and intermediate vs. high ($p < .05$) while there were no significant differences for low vs. intermediate, low vs. native, intermediate vs. native, and high vs. native. Thus, the high exhibited significantly higher CF for /s/ before a high front vowel compared to the low and the intermediate.

CF of /s/ occurring elsewhere was the highest in the intermediate at 7587.1 Hz (standard deviation = 1575.5 Hz) followed by the low at 7263.5 Hz (standard deviation = 1539.4 Hz), the high at 7262.7 Hz (standard deviation = 1323.3 Hz), and the native at 6604.1 Hz (standard deviation = 1305.8 Hz). According to an ANOVA, CF of /s/ occurring elsewhere was significantly different among the four groups ($df = 3$, $F = 5.613$, $p < .05$). A post-hoc test of LSD revealed significant differences for low vs. native, intermediate vs. native, and high vs. native ($p < .05$). Thus, it can be said that the three groups of Korean learners exhibited significantly higher CF for /s/ occurring elsewhere in comparison to the native group.

A series of *t*-tests were run to see if CF of /s/ was significantly different within each group according to the context of /s/ (i.e., before a high front vowel vs. elsewhere). A significant difference was attested in the high group ($t = 5.890$, $p < .05$). CF of /s/ was significantly higher before a high front vowel at

7873.4 Hz (standard deviation = 1596.6 Hz) than elsewhere at 7262.7 Hz (standard deviation = 1323.3 Hz). On the other hand, there was no significant difference in the low ($t = .818$, $p = .367$), the intermediate ($t = 3.166$, $p = .077$), and the native ($t = .969$, $p = .329$). Thus, the high group was different from the other three groups in that CF of /s/ was significantly higher before a high front vowel than elsewhere. In addition, it is notable that the low and the intermediate showed lower CF of /s/ before a high front vowel than elsewhere while the high and the native exhibited an opposite pattern.

To examine whether gender had any effect on CF of /s/, a MANOVA was run again with the dependent variables of CF and PAF and the independent variables of group (low vs. intermediate vs. high vs. native), gender (male vs. female), and context (before a high front vowel elsewhere). According to the analysis, there was a significant main effect of gender with CF ($df = 1$, $F = 191.403$, $p < .05$) and PAF ($df = 1$, $F = 119.920$, $p < .05$). CF of /s/ was significantly higher in the female group than in the male group (7972.6 Hz vs. 6287 Hz) (standard deviation = 1350.7 Hz vs. 1277.2 Hz). In addition, the female group illustrated a significantly higher PAF than the male group (7981.7 Hz vs. 5830 Hz) (standard deviation = 2197.2 Hz vs. 1822.7 Hz). There was also a significant interaction of group * gender with CF ($df = 3$, $F = 3.780$, $p < .05$). Figure 4 illustrates the finding.

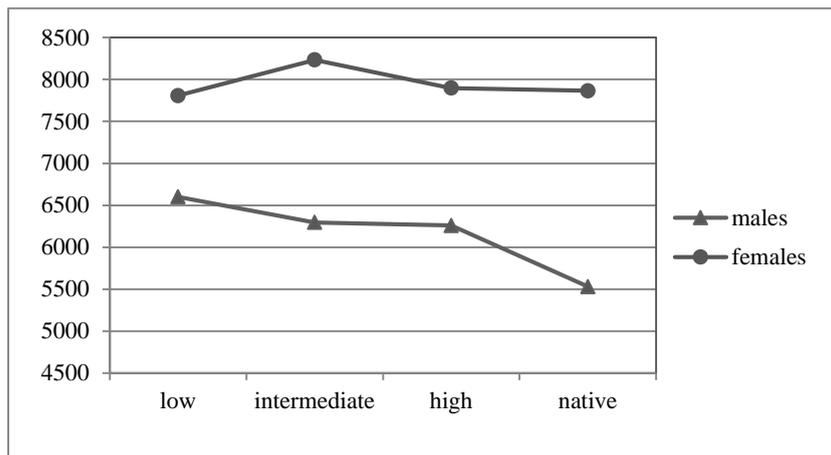


Figure 4. Mean CF of /s/ by group * gender

As can be seen from Figure 4, in the female group, CF of /s/ was the highest in the intermediate at 8232.6 Hz (standard deviation = 1545.8 Hz) followed by the high at 7898 Hz (standard deviation = 1229.8 Hz), the low at 7808.3 Hz (standard deviation = 1407.3 Hz), and the native at 7864.6 Hz (standard deviation = 816.7 Hz). According to an ANOVA, there was no significant difference among the four female groups with CF ($df = 3$, $F = 1.887$, $p = .132$).

In the male group, CF of /s/ was the highest in the low at 6600.1 Hz (standard deviation = 1431.4 Hz) followed by the intermediate at 6295 Hz (standard deviation = 1263.4 Hz), the high at 6259.4 Hz (standard deviation = 1117.1 Hz), and the native at 5529.5 Hz (standard deviation = 723.4 Hz). According to an ANOVA, in the male group, CF of /s/ was significantly different among the four groups ($df = 3, F = 6.064, p < .05$). A post-hoc test of LSD revealed significant differences for low vs. native, intermediate vs. native, and high vs. native ($p < .05$). Thus, it can be said that male Korean learners of English were different from the male native English speakers by showing significantly higher mean CF for /s/.

A series of *t*-tests were conducted to see whether there was a significant difference of CF according to gender within each group, and all the four groups showed a significant difference ($t = 30.795, p < .05$ for the low; $t = 73.881, p < .05$ for the intermediate; $t = 66.861, p < .05$ for the high; $t = 155.760, p < .05$ for the native). Thus, within all the four groups, significantly higher CF was attested for females than for males.

In addition, a marginally significant interaction of group * gender was found with PAF ($df = 3, F = 2.595, p = .052$). Figure 5 illustrates the finding.

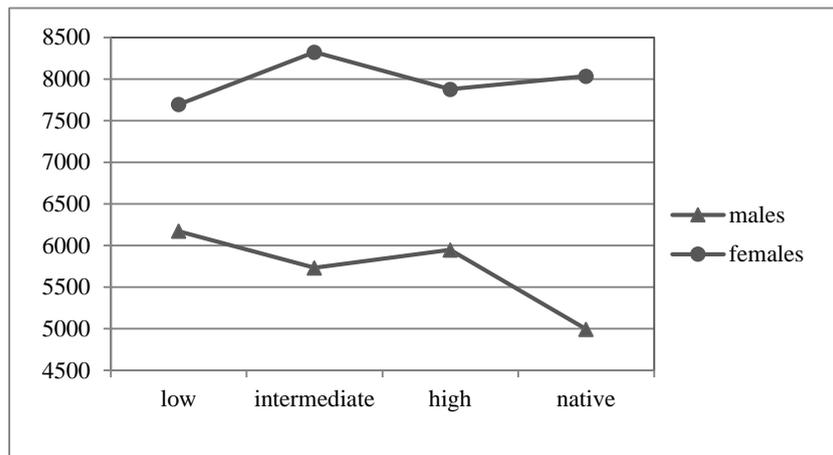


Figure 5. Mean PAF of /s/ by group * gender

The pattern of mean PAF of /s/ by group * gender was similar to that of mean CF of /s/. As can be seen from Figure 5, in the female group, PAF of /s/ was the highest in the intermediate at 8323.9 Hz (standard deviation = 2529 Hz) followed by the native at 8035 Hz (standard deviation = 1444.6 Hz), the high at 7877.4 Hz (standard deviation = 1983.9 Hz), and the low at 7695.9 Hz (standard deviation = 2281.1 Hz). According to an ANOVA, in the female group, PAF of /s/ was not significantly different according to group ($df = 3, F = 1.405, p = .241$). In the male group, the low exhibited the highest PAF of /s/

at 6172.2 Hz (standard deviation = 1864.8 Hz) followed by the high at 5948.2 Hz (standard deviation = 1726.5 Hz), the intermediate at 5732 Hz (standard deviation = 2068.8 Hz), and the native at 4993.2 Hz (standard deviation = 859 Hz). According to an ANOVA, males' PAF for /s/ was significantly different depending on group ($df = 3, F = 3.642, p < .05$). A post-hoc test of LSD revealed significant differences for low vs. native and high vs. native ($p < .05$). In addition, there was a marginally significant difference for intermediate vs. high ($p = .051$). A series of t -tests revealed significant differences of PAF according to gender within all the four groups ($t = 22.735, p < .05$ for the low; $t = 49.369, p < .05$ for the intermediate; $t = 36.385, p < .05$ for the high; $t = 111.368, p < .05$ for the native). These results show that females exhibited significantly higher PAF for /s/ than males in all the four groups.

A significant interaction of gender * context was attested with CF ($df = 1, F = 3.945, p < .05$). The finding is shown in Figure 6.

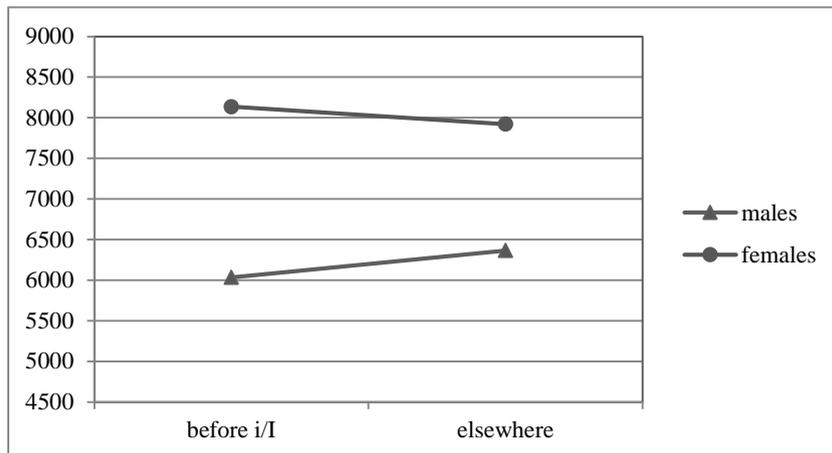


Figure 6. Mean CF of /s/ by gender * context

As shown in Figure 6, females exhibited higher CF when /s/ occurs before a high front vowel /i/ or /ɪ/ than when /s/ occurs elsewhere (8136.8 Hz vs. 7922.1 Hz) (standard deviation = 1463.7 Hz vs. 1312.8 Hz). A t -test revealed no significant difference ($t = 1.548, p = .214$). Males' CF was higher for /s/ elsewhere than for /s/ before /i/ or /ɪ/ (6364.8 Hz vs. 6033.8 Hz) (standard deviation = 1218.8 Hz vs. 1433.5 Hz). According to a t -test, the difference was not significant ($t = 2.899, p = .090$). A series of t -tests revealed that females' mean CF was significantly higher than males' in the context of before /i/ or /ɪ/ ($t = 69.158, p < .05$) and elsewhere ($t = 159.705, p < .05$). Thus, females showed significantly higher CF than males in the two contexts.

5 Discussion

Korean learners' production of English /s/ was different from the native English group's in that CF of /s/ was significantly higher in the three Korean groups than in the native English group. Considering that CF is inversely correlated with the length of the front cavity, it can be said that Korean learners produced English /s/ in a more fronted region of a vocal tract than the native English group. Sohn (1996) describes Korean /s/ as an alveo-dental consonant and Lee (1996) as an alveolar or a dental consonant depending on individuals. Following them, Korean learners' articulation of English /s/ in a more fronted region could have been influenced by their articulation of Korean /s/.

According to mean CF of /s/ by group * context, the high group illustrated a significantly higher CF of /s/ before a high front vowel than elsewhere while the low, the intermediate, and the native did not show any significantly different CF between those two contexts. This result shows that the low and the intermediate did not pronounce /s/ before a high front vowel in a more back region of a vocal tract than /s/ elsewhere with the influence of the Korean allophonic rule realizing /s/ as [ʃ] before a high front vowel. Our prediction was that Korean learners at lower proficiency levels in English will pronounce /s/ differently in the two contexts due to the interference of the Korean allophonic rule, but it was not confirmed according to the results of the present study.

In addition, mean CF of /s/ by group * context showed that the high group was different from the three groups by exhibiting a significantly higher CF of /s/ before a high front vowel than the context elsewhere. This result shows that the high group pronounced /s/ before a high front vowel with a more fronted place of articulation than /s/ elsewhere. As previously mentioned, with the interference of the Korean allophonic rule, it is expected that /s/ before a high front vowel will be palatalized as [ʃ], resulting in lower CF than /s/ in the context elsewhere. The high group learners' production of /s/ before a high front vowel in a more fronted place of a vocal tract could have been made due to their hyperarticulation in order not to apply the Korean allophonic rule when they pronounce English /s/ before a high front vowel, being aware of the difference of the rule application between Korean and English.

All the three groups of Korean learners showed significantly higher CF for /s/ occurring in the context elsewhere in comparison to the native group. This result makes sense if Korean /s/ is articulated in a more front region than English /s/ as an alveo-dental or dental as Lee (1996) and Sohn (1996) claimed and such L1 articulation affected the articulation of English /s/.

There was a significant main effect of gender with CF and PAF of /s/. Overall, females showed significantly higher CF and PAF of /s/ than males and this tendency was attested in all the four groups and in the two contexts concerned (i.e., before a high front vowel and elsewhere). This result stems from the biological characteristics occurring due to a speaker's gender. In

general, females have the smaller size of the resonance cavity and higher formant frequencies are attested in females' speech than in males' (Flipsen, Shriberg, Weismer, Karlsson, & McSweeney, 1999).

As for group * gender, the interaction was significant with CF and marginally significant with PAF, and the same pattern was observed. While there was no significant difference among the four groups of females, each of the three male Korean groups showed significantly higher CF and PAF than the male native English group. This result is not in line with Kong et al. (2014). In their study, gender differences were found in the production of Korean word-medial affricates due to females' more fronted articulation than males. According to Lee (1996), there is an individual difference when pronouncing Korean /s/ and it can be pronounced as either an alveolar consonant or a dental consonant. Thus, if the dental articulation of Korean /s/ is more frequently observed in males' speech, the result of the present study can be said to stem from L1 transfer. But to give such an explanation, it is required to investigate a gender-related difference in pronouncing Korean /s/.

Finally, mean PAF of /s/ was influenced by position while there was no effect of position with CF of /s/. Overall, PAF was lower in word-medial position than in word-initial or word-final position. This result might have occurred due to the overlapping gestures of /s/ with its preceding and following sounds.

6 Conclusion

In the present study, L1 and gender effects were examined in Korean learners' production of English /s/. The influence of the Korean allophonic rule realizing /s/ as [ʃ] before a high front vowel was not attested when Korean learners pronounced English /s/ before a high front vowel. The low and intermediate groups did not show any significant difference in the pronunciations of /s/ before a high front vowel and /s/ in the context elsewhere while the high group pronounced English /s/ before a high front vowel in a more front region of a vocal tract than English /s/ elsewhere. But it can be said that L1 effect was found in the pronunciation of English /s/ in the context elsewhere. All the three groups of Korean learners exhibited significantly higher CF in the context than the native English group and this may have been influenced by an alveo-dental or dental articulation of Korean /s/ (Lee, 1996; Sohn 1996). The interaction of group * gender showed that such an overall result occurred due to the male Korean groups. Significantly higher CF and PAF (i.e., more fronted articulation) were found in each of the three male Korean groups compared with the male native English group while there was no significant difference among the female groups. To confirm this result occurred due to the articulation of Korean /s/, it needs to be investigated whether an alveo-dental or dental articulation of Korean /s/ is more frequently observed in males' speech than in females'.

References

- Aoyama, K., Flege, J., Guion, S., Akahane-Yamada, R., & Yamada, T. (2004). Perceived phonetic dissimilarity and L2 speech learning: The case of Japanese /r/ and English /l/ and /r/. *Journal of Phonetics*, 32, 233-250.
- Best, C. T., & Strange, W. (1992). Effects of phonological and phonetic factors on cross-language perception of approximants. *Journal of Phonetics*, 20, 305-350.
- Behrens, S., & Blumstein, S. E. (1988). On the role of the amplitude of the fricative noise in the perception of place of articulation in voiceless fricative consonants. *Journal of the Acoustical Society of America*, 84, 861-867.
- Bergmann, A., Hall, K. C., & Ross, S. M. (2007). *Language files: Materials for an introduction to language and linguistics*. 10th ed. Columbus: Ohio State University Press.
- Borden, G., Gerber, A., & Milsark, G. (1983). Production and perception of the /r/-/l/ contrast in Korean adults learning English. *Language Learning*, 33(4), 499-526.
- Chang, C. B., Haynes, E. F., Yao, Y., & Rhodes, R. (2009). A tale of five fricatives: Consonantal contrast in heritage speakers of Mandarin. *University of Pennsylvania Working Papers in Linguistics*, 15(1), 36-43.
- Cho, Y.-M. (1990). *Parameters of consonantal assimilation* (Unpublished doctoral dissertation). Stanford University, Stanford.
- Cho, T., Jun, S.-A., & Ladefoged, P. (2002). Acoustic and aerodynamic correlates of Korean stops and fricatives. *Journal of Phonetics*, 30(2), 193-228.
- Flipsen, P., Shriberg, L., Weismer, G., Karlsson, H., & McSweeney, J. (1999). Acoustic characteristics of /s/ in adolescents. *Journal of Speech, Language, and Hearing Research*, 42, 663-677.
- Forrest, K., Weismer, G., Milenkovic, P., & Dougall, R. N. (1988). Statistical analysis of word-initial voiceless obstruents: Preliminary data. *Journal of the Acoustical Society of America*, 84(1), 115-123.
- Hume, E. (1992). *Front vowels, coronal consonants and their interaction in nonlinear phonology* (Unpublished doctoral dissertation). Cornell University, Ithaca.
- Jones, J. A., & Munhall, K. G. (2003). Learning to produce speech with an altered vocal tract: The role of auditory feedback. *Journal of the Acoustical Society of America*, 113, 532-534.
- Jongman, A., Wayland, R., & Wong, S. (2000). Acoustic characteristics of English fricatives. *Journal of the Acoustical Society of America*, 108, 1252-1263.

- Kim-Renaud, Y.-K. (1974). *Korean consonantal phonology* (Unpublished doctoral dissertation). University of Hawaii, Manoa.
- Kong, E., Kang, S., & Seo, M. (2014). Gender difference in the affricate productions of young Seoul Korean speakers. *Journal of Acoustical Society of America Express Letters*, 136(4), 329-335.
- Ladefoged, P. (2005). *Vowels and consonants*. 2nd ed. Malden, MA: Blackwell Publishing.
- Lee, H.-Y. (1996). *Kwuke um-seng-hak [Korean phonetics]*. Seoul: Taehaksa.
- McClelland, J. L., Thomas, A., McCandliss, B. D., & Fiez, J. A. (1999). Understanding failures of learning: Hebbian learning, competition for representational space, and some preliminary experimental data. *Progress in Brain Research*, 121, 75-80.
- Nittrouer, S., Studdert-Kennedy, M., & McGowan, R. S. (1989). The emergence of phonetic segments: Evidence from the spectral structure of fricative-vowel syllables spoken by children and adults. *Journal of Speech and Hearing Research*, 32(1), 120-132.
- Shadle, C. (1985). *The acoustics of fricative consonants* (Unpublished doctoral dissertation). Massachusetts Institute of Technology, Cambridge, MA.
- Shin, J. (2003). *Malsoliuy ihay [Understanding speech sounds]*. Seoul: Hankukmunhwasa.
- Shin, J., & Cha, J. (2004). *Wulimal soliuu cheykyey [The sound pattern of Korean]*. 2nd ed. Seoul: Hankukmunhwasa.
- Sohn, H.-M. (1999). *The Korean language*. Cambridge: Cambridge University Press.

Misun Seo, Professor
Department of English Language and Literature
Hannam University
70 Hannam-ro Daedeok-gu
Daejeon, 34430, Korea
Phone: 82-42-629-8461
Fax: 82-42-629-7321
E-mail: misunseo@hnu.kr

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