Recent studies show that, besides their effect on the f0 contour of the following vowel, Korean stops are undergoing a sound change in which a partial or complete VOT merger is taking place between aspirated and lax stops. Previous studies on sound change have mainly focused on group-normative effects, that is, effects that are representative of the population as a whole. The present study investigated interspeaker variation on sound change and focused on the role of the individual in the actuation of sound change. To see interspeaker variation, factors such as age, gender, dialect, and L2 proficiency were controlled. The results showed that the pooled data showed the VOT merger. However, individual speakers showed remarkable variations as follows: First, VOTs for both stops are getting shorter (VOT shortening). Second, there was an aspirated-shortening process. Third, there was a lax-lengthening process. Fourth, there is a merger variation. Remarkable interspeaker variations with controlled factors suggest: first, some speakers can be early adopters of sound change and more active propagators than others. Second, Korean is still undergoing a sound change. Further study is necessary to see whether there is a relationship between the merger and the shortening process.
INTRODUCTION

Sound change includes any processes of language change that affect pronunciation (phonetic change) or sound system structures (phonological change). Sound change can consist of the replacement of one speech sound by another, the complete loss of the affected sound, or even the introduction of a new sound in a place where there previously none. Recent studies show that, besides their effect on the f0 contour of the following vowel, Korean stops are undergoing a sound change in which a partial or complete VOT merger is taking place between aspirated and lax stops (Silva, 2006; Wright, 2008; Kang & Guion, 2008; M.-R. Kim, 2011b, 2012a, 2012b). Two phonetic processes toward the merger are involved: VOT shortening for aspirated stops vs. VOT lengthening for lax stops (M.-R. Kim, 2008). In addition, there is an onset-tone interaction because lax stops lower f0 whereas aspirated stops raise f0 (M.-R. Kim, 2000; Kim and Duanmu, 2004). Because of an onset-tone interaction and the merger, tone is an important cue to contrast aspirated and lax stops (Kim et al, 2002; Kim & Duanmu, to review). Two fundamental questions regarding sound change in contemporary Korean arise: How and why do sound patterns change (i.e., implementation and actuation problem)? In other words, what causes the inception of sound change in Korean?

In order to answer the fundamental questions on sound change in Korean, previous studies have discussed the effect of age, gender, dialect, and L2 proficiency on VOT (Silva, 2006; M.-R. Kim, 2008, 2011a, 2011b; Choi, 2002; Oh, 2011). However, their effects are not stable because of conflicting outcomes. Silva (2006) reported that the VOT merger occurred mainly among young speakers who were born after 1965. The findings were supported by Wright (2008, p. 74) and Kang & Guion (2008, p. 3913). However, M.-R. Kim (2008) reported that speakers even in their forties and fifties showed the VOT merger whereas some speakers in their twenties did not show the merger. If the effect of age on VOT merger is stable, we may expect that individual speakers in their twenties employed in the present study show the merger without interspeaker variation. The effect of dialect on VOT was reported in Choi (2002). She showed that Seoul Korean showed relatively more overlapping distribution in VOT than Chonnam Korean. However, her data showed interspeaker variations from Seoul speakers: out of two, one Seoul speaker alone showed a substantial VOT overlap between lax and aspirated stops (2002, p. 17). Furthermore, Cho et al (2002) showed the opposite pattern between Seoul and Cheju dialect. Unlike Choi (2002), they reported that the Cheju dialect exhibited more overlap in VOT ranges than the Seoul dialect. Recently, Oh (2011) reported the effect of gender in that the merger phenomenon is stronger for females than males. Her results suggest that female speakers are more innovative than male speakers to lead a sound change. M.-R. Kim (2011b) provided some evidence of the effect of L2 proficiency on VOT: for both L1 and L2 stops, the more proficient, the shorter VOTs. She reported that the merger was more frequent among advanced L2 speakers than among L2 beginners.

The aforementioned studies overall suggest that the effect of age, gender, dialect, and L2 proficiency on VOT was not stable because of conflicting findings. In addition previous studies on sound change have mainly focused on group-normative effects, that is, effects that are representative of the population as a whole. Little attention has been paid to interspeaker variations on sound change and the role of individuals in the actuation of sound change. The present study investigates interspeaker variation on sound change and focused on the role of the individual in the actuation of sound change. To see interspeaker variation, factors such as age, gender, dialect, and L2 proficiency in which their effects have been controversial were controlled.

METHODS

Speakers

Participants were recruited around the University of Oregon campus. Thirteen native speakers of Seoul Korean, 5 males and 8 females, participated in the experiment. The mean age was 32 years, 5 months and the individuals ranged from 20 years, 6 months to 37 years, 2 months. They had lived in Eugene, Oregon no less than 6 months at the time of the recording. They had learned English after their puberty. All of participants were asked to fill out their language background questionnaire prior to recording. No speakers had any history of speech pathology or phonetic training.

Speech materials and procedure

Eighteen monosyllabic words were balanced for phonation types (lax, aspirated, and tense) followed by a vowel /a/ context. The syllable type was either CV or CVC. The target words consisted of real and nonce words, as
presented in Table 1.

**TABLE 1.** Monosyllabic speech stimuli

<table>
<thead>
<tr>
<th>Type</th>
<th>Phonation</th>
<th>Bilabial</th>
<th>Alveolar</th>
<th>Velar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real</td>
<td>Aspirated</td>
<td>[pʰat] ‘red bean’</td>
<td>[tʰat] ‘blame’</td>
<td>[kʰat] ‘stop’</td>
</tr>
<tr>
<td></td>
<td>Lax</td>
<td>[pat] ‘field’</td>
<td>[tat] ‘anchor’</td>
<td>[kat] ‘cap (old)’</td>
</tr>
<tr>
<td>Nonce</td>
<td>Aspirated</td>
<td>[pʰa]</td>
<td>[tʰa]</td>
<td>[kʰa]</td>
</tr>
<tr>
<td></td>
<td>Lax</td>
<td>[pa]</td>
<td>[ta]</td>
<td>[ka]</td>
</tr>
<tr>
<td></td>
<td>Tense</td>
<td>[pʰa]</td>
<td>[tʰa]</td>
<td>[kʰa]</td>
</tr>
</tbody>
</table>

(Tense stops are phonetically transcribed as /pʰ tʰ kʰ/, lax or lenis as /p t k/, and aspirated as /pʰ tʰ kʰ/)

The target words were recorded in the carrier sentence for target words was [igο hasqο] “Say this ______.” Speech materials were presented in *Hangul*, the writing system of Korean. Recordings were made in a sound-attenuated booth in the Phonetics Lab using a Shure (model SM 10A) head-mounted microphone and a Marantz digital recorder (PMD 670) at a sampling rate of 44,100 Hz. Each speaker was asked to read the words on the monitor in a natural intonation. The monitor connected to the computer was inside the lab but the computer itself was outside the lab to minimize background noise. The words were automatically popped up at a 3-second interval. A total of 936 tokens (18 words x 4 repetitions x 13 speakers) were obtained for analysis. All recorded utterances were analyzed using Praat 5.1.05, a speech analysis program (Boersma & Weenink, 2011).

VOT was measured from the release burst to the onset of periodicity in the waveform (Lisker & Abramson, 1964). The onset of the vowel in the waveform was determined by the onset of the first full glottal pulse of the vowel as well as the pitch of the spectrogram. The onset of the voicing energy in the second formant shown in a time-locked spectrogram was used to help determine voicing onset in conjunction with the waveform. The onset of voicing (= vowel onset) was defined as the first and periodic pulse of a vocalic waveform that show features typical of a vowel.

**RESULT AND DISCUSSION**

**VOT merger and shortening**

Previous studies show that a partial or complete VOT merger is taking place between aspirated and lax stops (Choi, 2002; Silva, 2006; M.-R. Kim, 2008, 2011a, 2011b; Wright, 2008; Kang & Guion, 2008; Oh, 2011; Oh & Dalland, 2011). As expected from previous studies, the results in the current study showed that there was an apparent VOT merger between aspirated and lax stops. Tense stops are distinguished from either aspirated or lax stops whereas aspirated stops are not well-distinguished from lax stops in terms of VOT. To help visualize the merger between aspirated and lax stops, Figure 1 was plotted with the mean VOT values according to each phonation type. For each phonation type, the plot was generated by averaging across thirteen speakers.

As can be seen in Figure 1, tense stops are realized with short-lag VOT ($M_{tense} = 13$ ms (10 ms ~ 15 ms)). However, both aspirated and lax stops are realized with long-lag VOT ($M_{aspirated} = 79$ ms (41 ms ~ 110 ms); $M_{lax} = 69$ ms (35 ms ~ 111 ms)). There was a significant main effect of phonation type because of the expected VOT differences between tense and lax or aspirated stops ($p < 0.01$). Post-hoc pairwise comparisons between the phonation types showed that there was no significant differences between aspirated and lax stops ($p > 0.05$). However, the rest pairwise comparisons (tense vs. lax and tense vs. aspirated) showed significant differences ($p < 0.01$). The merger process can be characterized as either VOT shortening or lengthening process in the production of the two stop types. Compared with Lisker and Abramson’s (1964) findings, mean VOT values for aspirated stops are getting much shorter ($M_{aspirated} = 103$ ms $\rightarrow 79$ ms) whereas mean VOT values for lax stops are getting much longer ($M_{lax} = 30$ ms $\rightarrow 69$ ms). From the pooled data, the sound change phenomena in Korean can be characterized by three phonetic processes: VOT merger, VOT shortening, and VOT lengthening. Next section the issue of how individual speakers implement these phonetic processes will be discussed.
FIGURE 1. Overall mean VOT values to each phonation type. Data are averaged across thirteen speakers (5 male and 8 female). Error bar indicates ±1 standard deviation.

**Interspeaker variation on VOT**

Speakers employed in the present study were from same dialects in their twenties and thirties. In addition, their L2 proficiency was controlled. Despite the fact that their effects on age, gender, dialect, L1 proficiency were controlled, individual speakers showed remarkable variations on the VOT merger, shortening, and lengthening. The individual plots of VOT values according to each phonation types are illustrated in Figure 2.

FIGURE 2. Overall mean VOT values to each phonation type for the productions of individual speakers. Error bar indicates ±1 standard deviation. The horizontal line represents mean VOT of the group.

As can be seen in Figure 2, interspeaker variations are huge when speakers produce aspirated and lax stops, in particular in terms of a VOT merger and VOT duration. With respect to the VOT merger, speakers roughly show three different patterns: no merger, partial merger, and complete merger. The no merger pattern corresponds to the early findings where VOT values was the longest for aspirated stops, the intermediate for lax stops, and the shortest for tense stops, that is, three-way VOT differences. This three-way or no merger pattern can be observed from the VOT productions of speaker HRH ($M_{\text{aspirated}} = 63$ ms, $M_{\text{lax}} = 36$ ms, and $M_{\text{tense}} = 10$ ms). However, compared with early findings on VOT, she produced relatively shorter VOTs for aspirated stops ($M_{\text{asp}} = 103$ ms in Lisker and Abramson, 1964), indicating that she has a shortening process for aspirated stops. Because of this shortening process
for aspirated stops, she showed some overlap between lax and aspirated stops in the VOT range (M_aspiration = 63 ms (46 ms–83 ms ), M_lax = 36 ms (17 ms–52 ms ). The partial or complete merger patterns corresponds to the pattern that shows two-way VOT differences between short-lag and long-lag voicing because of the VOT overlap between aspirated and lax stops. This two-way or merger pattern can be observed nine out of thirteen speakers. The pattern can be observed from speaker SHK’s plots for the example of a partial merger (M_aspiration = 96 ms, M_lax = 73 ms, and M_tense = 15 ms) and speaker HJK for that of a complete merger (M_aspiration = 85 ms, M_lax = 78 ms, and M_tense = 10 ms).

With respect to sound change on VOT duration, three different patterns can be observed: shortening (below group mean), lengthening (above group mean), and the opposite pattern where VOTs for lax stops are even longer than that for aspirated stops. The term shortening will be applied for speakers who had shorter mean VOT than group mean. The term lengthening will be applied for speaker who had longer mean VOT than group mean. In Figure 2, taking the horizontal line as a reference point in consideration, six out of thirteen speakers show a shortening process on VOT for aspirated stops. Five out of six speakers produced lax stops short VOT values below group mean as well. Compared with early findings, there is a lengthening process for lax stops. Nine out thirteen speakers produced lax stops with relatively longer VOTs. For speaker SNC, VOT values for lax stops are even longer than those for aspirated stops (M_aspiration = 85 ms and M_lax = 92 ms). Compared with Lisker and Abramson’s VOT values (M_aspiration = 103 ms, M_lax = 30 ms), most of speakers showed relatively longer VOTs for lax stops whereas they showed shorter VOTs for aspirated stops. In other words, the sound change can be characterized by VOT shortening for aspirated stops but VOT lengthening for lax stops. Table 2 presents the summary of interspeaker variations on the phonetic implementations of VOT.

**TABLE 2.** The summary chart of interspeaker variation on VOT implementation

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Merger</th>
<th>Individual</th>
<th># spkrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merger</td>
<td>No</td>
<td>HRH, JHP, MHP, MYH,</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Partial or complete</td>
<td>AYK, HJK, MKJ, SHK, SNC, TWK, YHK, YHS</td>
<td>9</td>
</tr>
<tr>
<td>Shortening</td>
<td>Aspirated</td>
<td>AYK, HRH, JHK, MYH,</td>
<td>6</td>
</tr>
<tr>
<td>Lengthening</td>
<td>Lax</td>
<td>HJK, JHP, MKJ, SHK, SNC, TWK</td>
<td>8</td>
</tr>
<tr>
<td>Opposite</td>
<td>Asp &lt; lax</td>
<td>JHK, MKJ, SNC, TWK, YHS</td>
<td>5</td>
</tr>
</tbody>
</table>

(Tense stops are phonetically transcribed as /pʰ tʰ kʰ/, lax or lenis as /p t k/, and aspirated as /pʰ hʰ tʰ kʰ/)

**Effects of age, gender, dialect, and L2 proficiency on VOT are not stable.**

If there is an effect of age, gender, and dialect, and L2 proficiency on VOT, we may expect that individuals under the controlled factors show similar VOT implementations on the merger and shortening process. In Figure 2, let’s compare speaker JHK with speaker TWK for the plots of aspirated and lax stops. They both were male speakers (same gender), in their twenties (23 vs. 20) and they grew up in Seoul (i.e., same dialect). In addition, they had lived in the USA no more than 2 months (similar L2 exposure). In other words, their language background on those factors is the same. However, regardless of similar background, their VOT plots between aspirated and lax stops are strikingly different. As can be seen in Figure 2, the two speakers show some merger between the two stops in that speaker JHK had a complete merger and speaker TWK had a partial merger. However, the overall mean VOT values for both aspirated and lax stops for TWK are twice as long as those of speaker JHK (M_aspiration = 108 ms and M_lax = 112 ms vs. M_aspiration = 59 ms and M_lax = 56 ms). Toward the merger, it seems that speaker JHK was undergoing a shortening process for aspirated stops whereas speaker TWK was undergoing a lengthening process for lax stops. Either way resulted in the merger. Speaker JHP had the same language background as speaker JHK and TWK. However, his pattern is different from them. Although he had a quite long range of VOT for aspirated stops (M_aspiration = 104 ms (70 ms ~ 143 ms)) as well as lax stops (M_lax = 77 ms (49 ms ~ 118 ms)), his pattern belonged to no merger pattern.

Similarly, interspeaker variations can be observed among female speakers. With respect to the merger, speaker YHK showed a merger whereas speaker YHK did not. Speaker YHK had much shorter VOT values than speaker MHP (M_aspiration = 42 ms and M_lax = 37 ms vs. M_aspiration = 110 ms and M_lax = 75 ms). For speaker MHP, neither merger nor shortening had occurred. However, for speaker YHK, both merger and shortening had occurred. Interspeaker
variations on VOT can be similarly observed from other female speakers.

Compared with early findings on VOT for lax and aspirated stops, interspeaker variations consist of three different phonetic processes. First, there is interspeaker variation on VOT merger. Second, there is interspeaker variation on VOT shortening for either aspirated or lax stops. Third, there is interspeaker variation on VOT lengthening for aspirated stops. Remarkable interspeaker variations with controlled factors suggest: first, some speakers can be early adopters of sound change and more active propagators than others. Second, Korean is still undergoing a sound change.

From the results of early adopters of sound change, we can predict how one sound can replace the other and what phonetic processes are involved as follows: first, aspirated stops may decrease the amount of aspiration (i.e., shortening). Second, lax stops may increase the amount of aspiration (i.e., lengthening). The ongoing processes of shortening and lengthening will result in the merging of aspirated and lax stops. One question arises whether the shortening process is the prerequisite for the merger of the two stops. As can be seen in Figure 2, the merger can be observed even without a shortening process. Speaker TWK produced relatively longer VOTs for both aspirated and lax stops, compared with other speakers. However, his data showed the merger. For this speaker, he did not have a shortening process for aspirated stops whereas he had a lengthening process for lax stops instead. This suggests that a speaker may choose either VOT shortening for aspirated stops or VOT lengthening for lax stops. If it does, a speaker can play an active role in sound change.

Another question arises how and why a speaker chooses the direction of sound change in terms of VOT duration (short $\rightarrow$ long or long $\rightarrow$ short). As can be seen in Figure 2, six out of thirteen choose a VOT shortening for aspirated stops whereas eight speakers choose a VOT lengthening for lax stops toward the merger. One of the great mysteries of linguistics is the so-called actuation problem, that is, what causes the inception of language change. Starting with Weinreich’s classic book Languages in Contact (1953), research over the past half-century has brought about a recognition of the importance of language contact for explanations of many linguistic changes. M.-R. Kim (2011b) reported that aspirated stops in Korean can be shortened because of the influence of L2 English. If language contact plays a role for sound change in Korean, further study is necessary to see the effect of L2 English proficiency on sound change.

Acknowledgments

This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2012-2012S1A5A2A01018746). I thank participants for their speech materials.

References


Kim, M.-R. (2011b). “The relationship between cross-language phonetic influences and L2 proficiency in terms of...


