

Native and Non-Native English Speakers’ Production of Voiceless Stops: Effects of Lexical Stress and Prosodic Domain on VOT

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1. Introduction

It has been widely accepted that L2 learners’ pronunciation might be different from that of native speakers of a language. There are mainly three reasons to this difference in pronunciation. First, it might be due to an absence of certain sounds in the phoneme inventory of L2 learners’ mother tongue. For example, Korean speakers’ production of /r/ might differ from that of English speakers, as the liquid does not exist in Korean phonemic inventory. Second, it may also be the case that their pronunciation differs from natives’ even for the phonemes that are attested in both languages. This is often because some phonetic features are phonemic in one language, but sub-phonemic in another. Voiceless stops in English and Korean are one example. In English, phonetic realization of voiceless stops varies with the phonological environment in which they occur. English voiceless stops are aspirated in word-initial position as in *pín* [p^hín], or more specifically, in syllable-initial position as in *impóund* [imp^háónd] when the syllable is stressed. For example, /p/ is heavily aspirated in *pénd* [p^hénd] and *depénd* [dip^hénd] as it falls in the stressed syllables, in word-initial and word-medial position respectively; in comparison, /p/ in *háppened* [hæpénd] is unaspirated as it occurs word-medially in the unstressed syllable. This is because aspiration is an allophonic cue in English. In contrast, aspirated and unaspirated voiceless stops are contrastive in Korean, i.e., different phonemes as in

Table 1. Four different environments in which voiceless stops are placed in the experiment

		prosodic domain	
		word-initial	word-medial
stress	stressed	<i>pénd</i>	<i>depénd</i>
	unstressed	<i>pursúit</i>	<i>happened</i>

[p^hul] ‘grass’ and [pul] ‘fire.’

The third reason why L2 learners’ pronunciation might be different from that of natives is because certain phonological features do not exist in their mother tongue. For example, while English has lexical stress, which may serve to distinguish words, Korean is a language with no lexical stress. Considering this difference in the two languages, it would be of great interest to examine how Korean speakers differ from English speakers in producing English voiceless stops in words with different stress patterns. In this paper, voiceless stops are placed in one of the four following phonological environments – they differ in terms of either the location in a word (i.e., word-initial vs. word-medial) or the realization of stress (i.e., stressed and unstressed). The combination of the each factor expected to influence the degree of aspiration, along with the examples, are presented in Table 1.

The purpose of this study is to examine how non-native speakers of English (i.e., Korean speakers) production of voiceless stops differ from that of native speakers (i.e., English speakers). A production study is designed to compare the two groups of speakers’ production of English voiceless stops in four different phonological environments.

In this study, realization of aspiration is examined by measuring voice onset time (VOT). VOT refers to the period of voicelessness between the release of a stop and the onset of voicing. Length of VOT is typically adopted as a means of measuring different degrees of aspiration; longer VOT means the stop is more heavily aspirated.

Numerous studies have found a number of phonological factors that can influence L2 production of VOT (Antoniou, Best, Tyler, & Kroosa, 2011; Au, Knightly, Jun, & Oh, 2002; Flege, 1991). Some studies paid a closer atten-

tion to Korean speakers' production of VOT for English stops (Kim, 2011a, 2011b, 2012; Oh & Daland, 2011). They found several phonological factors that resulted in a number of ways in which Korean speakers' production of VOT differed from English speakers. For instance, Kim (2011b) argued that Korean speakers with high proficiency in English were more likely to show similar patterns of production of VOT to that of English speakers. In addition, Kim (2012) suggested that an ongoing sound change in Korean in which f_0 is a primary cue and VOT is a secondary cue for distinguishing lax and aspirated stops served to contrast English voiced and voiceless stops. Though the previous studies take into consideration some factors such as English proficiency of Korean speakers and the sound change in Korean, none of them looked thoroughly at stress effects on VOT in Korean speakers' production of English voiceless stops. The present study aims to investigate how the influences of stress may differ in English and Korean speakers' production of the stops.

Phonetic realizations of aspiration according to prosodic features have been largely discussed (Cho & Keating, 2009; Keating, Cho, Fougeron, & Hsu, 2003; Klatt, 1976). A number of previous studies focused particularly on the effects of lexical stress on VOT in English. Gimson (1962) pointed out that voiceless stops show a wide range of aspiration depending on the degree of stress (as cited in Lisker & Abramson, 1967, p.15). Hoard (1971) also noted that word-initial voiceless stops bear weaker aspiration if the syllable is unstressed. Recently, it was found in Cho and McQueen (2005) that shorter VOTs were observed for /t/ in Dutch in stronger locations, i.e., stressed, accented and domain-initial positions, while longer VOTs were found in English in the same positions. This finding indicates that the same prosodic condition might have different effects on different languages. In this study, it should be noted that Korean bears no distinct lexical stress and that Korean speakers are rarely sensitive to lexical stress when speaking in their mother tongue. Thus, it can be assumed that while English speakers are highly likely to produce different degrees of VOT as stress placement varies within a word, the patterns of VOT in Korean speakers' production of English stops might be different from that of English speakers.

In addition, it was pointed out in a great deal of previous research that prosodic boundary in which stops are placed is one of the critical factors that may affect VOT. More specifically, evidence was found for what is called domain-initial strengthening. Domain-initial strengthening refers to a phenomenon in which consonants are strongly articulated in domain-initial positions of each prosodic level i.e., word, intermediate phrase and intonational phrase level, than in domain-medial positions. Cho & Keating (2009), for instance, found that VOT was longer in utterance-initial /t/ in English. As regards Korean, Jun (1993) argued that aspiration in /p^h/ was observed to be longer word-initially than in word-medial positions. Similarly, Cho and Keating (2001) found that Korean /t, t^h/ exhibited longer VOTs when they occur in a higher domain-initial positions. In this paper, voiceless stops were placed in two prosodic domains, i.e., word-initial and word-medial position to investigate domain effect on VOT.

In sum, while a great deal of research has been conducted regarding both Korean speakers' production of VOT in English stops and the influence of prosodic factors on VOT, little research has been done in terms of the influence of lexical stress and prosodic domain on VOT in Korean speakers production of English voiceless stops. This study aims to investigate the way lexical stress and prosodic domain affect English and Korean speakers' production differently. A couple of hypotheses may be established in terms of Korean speakers' sensitivity to lexical stress; they may be either sensitive or insensitive to lexical stress. First, it can be hypothesized that as lexical stress is not attested in Korean, Korean speakers would not be sensitive to lexical stress in English. In this case, their production of VOT is not likely to be affected by stress placement on stops. Consequently, VOT in stressed and unstressed syllables will differ less than that of English speakers. An alternative is that even though stress does not exist in their mother tongue, Korean speakers would still be sensitive to lexical stress. Evidence has been found that non-native speakers adapt to phonetic cues that do not exist in their mother tongue. For instance, Korean speakers realize different vowel lengths in English words, such as *beat* [bit] and *bit* [bit], even though vowel length is not distinctive in Korean. Similarly, Korean speakers would be

sensitive to stress and incorporate it in their L2 speech. It may be the case that they would be highly conscious about the lexical stress included in the stimuli words and even more sensitive to stress information than English speakers. In such case, the difference in the length of VOT in stressed and unstressed syllables in Korean speakers' speech will be greater than that of English speakers.

Regarding effects of prosodic domain on VOT, it is expected that both English speakers and Korean speakers will produce different lengths of VOT depending on the position of voiceless stops within a word. More specifically, considering that domain-initial strengthening was found in previous studies, the same would be seen in this study as well – when the stops are placed in word-initial position (i.e., domain-initial position), both groups are likely to produce longer VOTs than in word-medial position (i.e., domain-medial position).

2. Methods

2.1. Participants

Participants consisted of two speech groups – English and Korean speakers. Each group had 3 speakers. Participants were aged between 24 and 27, with an average age of 25. None of them reported having a language or a reading disorder. The English speakers reported that their mother tongue was English. Although they were also fluent in Korean as they have lived in Korea for a few years, they considered themselves native speakers of English. Three Korean speakers were born and raised in Korea. They have lived in Seoul for most of their lives and speak in standard Korean; thus, there was no dialectal influence on the results. They all started to learn English around age 10 and were mainly educated in Korea.

2.2. Materials and Recording Procedures

The speech materials consisted of total 48 English disyllabic non-words, which are presented in Table 2. They were divided into four different groups of words. Each group contained words with voiceless stops in one of four

Table 2. The stimuli for VOT measurement

		prosodic domain				
		word-initial		word-medial		
stress	stressed	Set 1		Set 3		
		/p/	<i>péndurse</i> <i>pérfine</i> <i>pérséct</i> <i>púrfew</i>	[péndərs] [pərfám] [pərsékt] [pərfju]	<i>inpurse</i> <i>inpend</i> <i>enpile</i> <i>repail</i>	[inpərs] [inpend] [inpaíl] [ripéil]
		/t/	<i>tésfine</i> <i>tínside</i> <i>tíspect</i> <i>túrñail</i>	[tésfám] [tínsaid] [tíspekt] [tərneil]	<i>entile</i> <i>contail</i> <i>entain</i> <i>detore</i>	[intáil] [kántéil] [intéim] [dítər]
	/k/	<i>cóbust</i> <i>cónmile</i> <i>kélláin</i> <i>kíndale</i>	[koóbəst] [kánmaíl] [kélem] [kíndeil]	<i>becane</i> <i>recore</i> <i>decúr</i> <i>recand</i>	[bíkéin] [ríkər] [díkər] [ríkænd]	
	unstressed	Set 2		Set 4		
		/p/	<i>pendúrse</i> <i>perfine</i> <i>perséct</i> <i>purféw</i>	[pendərs] [pərfám] [pərsékt] [pərfju]	<i>inpurse</i> <i>inpend</i> <i>enpile</i> <i>repail</i>	[inpərs] [inpend] [inpaíl] [ripéil]
/t/		<i>tesfine</i> <i>tínside</i> <i>tispéct</i> <i>turnáil</i>	[tesfám] [tínsaid] [tispékt] [tərneil]	<i>éntile</i> <i>cóntail</i> <i>éntain</i> <i>détore</i>	[intáil] [kántéil] [intéim] [dítər]	
/k/	<i>cobúst</i> <i>conmíle</i> <i>kélláin</i> <i>kíndále</i>	[koobást] [kanmaíl] [kelém] [kíndeil]	<i>bécane</i> <i>récore</i> <i>décur</i> <i>récand</i>	[bíkem] [ríkər] [díkər] [ríkænd]		

different phonological environments that were presented in Table 1. Set 1 and 2 contained voiceless stops in word-initial positions. Words included in the two sets had the same segments, while they differed in placement of stress. Words in Set 1 were stressed on the first syllable so that word-initial voiceless stops were placed in stressed syllables, while those in Set 2 were stressed on the second syllable so that voiceless stops were placed in unstressed syllables. Set 3 and 4 contained voiceless stops in word-medial positions. As was the case in Set 1 and 2, words included in Set 3 and 4

were basically the same strings of segments with different stress placement – word-medial voiceless stops occurred in stressed syllables in Set 3 and in unstressed syllables in Set 4. Each set included an equal number of words containing /p/, /t/ and /k/, i.e., four words each for the three voiceless stops.

The speech materials were provided in English orthography. The participants produced each word in very similar pronunciations. Their pronunciation of each word is transcribed in IPA in Table 2. Considering that in many cases /k/ in English is written in orthographic ‘c,’ most of the /k/ sounds were transcribed as ‘c’ in the stimuli as well. As expected, all of the ‘c’s were in fact pronounced as /k/ in all tokens. Each stimulus was embedded in a carrier sentence “Say ____ again.” Participants were asked to repeat each set three times.

2.3. Acoustic Analysis

864 tokens (4 sets × 12 words × 6 speakers × 3 times) were collected in total. Using Praat 5.4.09, the temporal duration of voicelessness (i.e., VOT) in /p/, /t/ and /k/ was measured. VOT was measured from the release burst of the stops to the onset of voicing. Below is an example of waveform and spectrogram for voiceless stops in the experiment, with the selected area designating VOT measured.

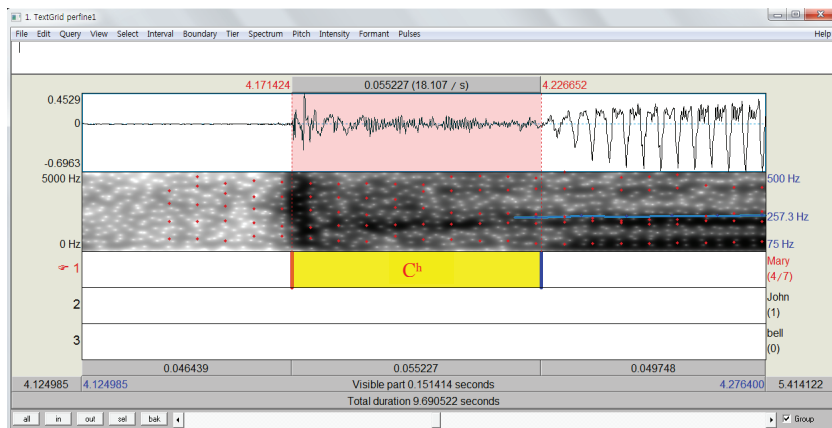


Figure 1. VOT of /p/ in *pérfine* produced by English speaker 2 (the second token). The selected area represents aspiration in voiceless stops (C=/p, t, k/)

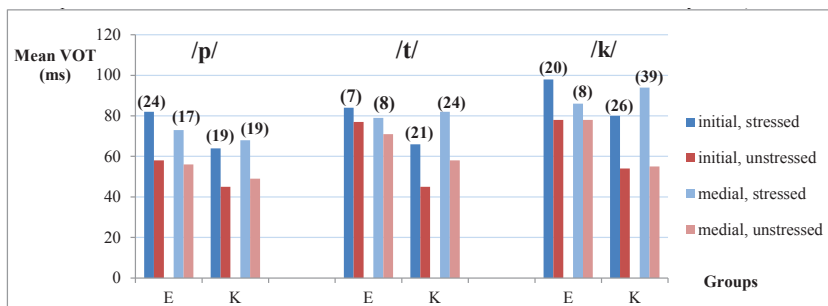


Figure 2. The mean VOT values (ms) of each group depending on stress placement. (Each figure in parentheses is the difference between mean VOT values in stressed and unstressed syllables)

3. Results

VOT for voiceless stops of two groups according to stress pattern and prosodic domain was examined. Figure 2 summarizes the result of this study, presenting all the variables considered in the experiment – the mean VOT values of word-initial and word-medial voiceless stops produced by English and Korean speakers, both in stressed and unstressed syllables.

Overall, the mean VOT of voiceless stops for English speakers were longer than Korean speakers given the same condition of stress and prosodic domain. It is presented that in word-initial position, for both stressed and unstressed conditions, English speakers produced much longer VOTs than Korean speakers. While English speakers produced longer VOTs for word-medial voiceless stops in unstressed positions compared to Korean speakers, it was not always the case in stressed syllables. More specifically, although the mean VOT values for /p/ produced by English speakers were longer than that of Korean speakers, the opposite was found for /t/ and /k/. Therefore, from the results of English and Korean speakers' production of VOT in all four environments, it can be said that English speakers produced longer VOTs in general with a few exceptions.

It was also found that in both speaker groups, the mean VOT values in stressed syllables were invariably longer than in unstressed syllables,

regardless of place of articulation. This finding is in line with numerous previous studies that reported voiceless stops are more heavily aspirated in stressed syllables than in unstressed ones (Cho & McQueen, 2005; Hoard, 1971; Lisker & Abramson, 1967).

Place of articulation of the stops was also found to affect length of VOT. For both English and Korean speakers, provided the same stress and domain condition, it is observed that the mean VOTs of /p/ are the shortest and /k/ the longest in most of the cases. In other words, VOT increases as the place of articulation moves from lips to velum.

In the next section, a detailed analysis is given on how English speakers and Korean speakers' production of the voiceless stops differ from each other according to stress placement.

3.1. The Influence of Stress Placement on VOT

The results show that Korean speakers' production of VOT depending on stress condition showed a different pattern from that of English speakers. To be more specific, Korean speakers generally produced a greater difference in VOT values between voiceless stops in stressed and unstressed syllables.

Word-initial position An independent-samples t-test was conducted to compare VOT values for word-initial /p/, /t/ and /k/ in stressed and unstressed syllables. Results indicate that Korean speakers produced word-initial voiceless stops differently than English speakers, depending on whether the stops were placed in stressed or unstressed syllables. First of all, for /p/, there was a significant difference in the VOT values for stressed and unstressed conditions for English speakers ($t(70)=4.4$, $p < 0.0001$). For Korean speakers, there was also a significant difference in the /p/ VOT values for stressed and unstressed conditions ($t(69)=4.8$, $p < 0.0001$). Therefore, it can be concluded that both groups produced significantly different VOTs in the two conditions, i.e., /p/ in stressed and unstressed positions. Rather different result was observed for /t/. For English speakers, there was no significant difference in the /t/ VOT values for stressed and unstressed conditions ($t(70)=1.4$, $p > 0.05$). In contrast, for Korean speakers, a significant differ-

ence was found in the /t/ VOT values for stressed and unstressed syllables ($t(54)=5.5$, $p < 0.0001$). It should be noted from Figure 2 that the difference between mean VOT values for /t/ in stressed and unstressed syllables was only 7 ms for English speakers, but 21 ms for Korean speakers. Thus, it is clearly shown that while VOT production of Korean speakers for /t/ varied with stress placement that of English speakers did not. Finally, in producing /k/, both groups produced /k/ in stressed and unstressed syllables differently, but the effect of stress was seen to be stronger for Korean speakers. For English speakers, there was a significant difference in the /k/ VOT values for stressed and unstressed conditions ($t(69)=4.0$, $p < 0.001$). For Korean speakers, there was also a significant difference in the /k/ VOT values for stressed and unstressed syllables ($t(70)=7.1$, $p < 0.0001$). However, note that the difference between mean VOT values for /k/ in stressed and unstressed syllables was larger for Korean speakers (20 ms for English speakers, and 26 ms for Korean speakers), even though VOT values for both stressed and unstressed conditions were shorter in the Korean speaker group. Therefore, it can be said that Korean speakers' production of /k/ VOT depending on stress placement varied in a greater degree than that of English speakers. Overall, the results for /p/, /t/ and /k/ taken altogether, it can be concluded that the difference in VOT values for word-initial voiceless stops in stressed and unstressed syllables was greater for Korean speakers than English speakers, though the results more or less varied with place of articulation of the stops.

Word-medial position Figure 2 also presents the mean VOT values of word-medial /p/, /t/ and /k/ produced by English and Korean speakers in syllables with and without stress. An independent-samples t-test was carried out as well to compare VOT values for word-medial voiceless stops in stressed and unstressed syllables, which showed a similar pattern as in word-initial position. As was the case in word-initial condition, English speakers and Korean speakers showed different patterns in their production of the stops when stress placement varied. First, for word-medial /p/, both groups produced the stop in stressed and unstressed syllables differently,

but the effect of stress was observed to be stronger for Korean speakers. For English speakers, a significant difference was found in the /p/ VOT values for stressed and unstressed conditions ($t(70)=2.9$, $p < 0.01$). For Korean speakers, there was also a significant difference in the /p/ VOT values for stressed and unstressed syllables ($t(70)=4.1$, $p < 0.001$). While both groups showed a significant difference in the two conditions, the difference in the VOT values for stressed and unstressed syllables was 17 ms for English speakers, and a slightly greater 19 ms for Korean speakers. Second, as regards /t/ in word-medial positions, somewhat similar result was seen as in word-initial /t/. For English speakers, there was not a significant difference in the /t/ VOT values for stressed and unstressed conditions ($t(57)=1.4$, $p > 0.05$). In contrast, for Korean speakers, a significant difference was discovered in the VOT values for /t/ in stressed and unstressed syllables ($t(63)=4.8$, $p < 0.0001$). It is clear that whereas VOT production of Korean speakers for /t/ varied with stress placement, that of English speakers did not, in both word-initial and word-medial conditions. Third, the effect of stress was observed for both groups in producing /k/. In English speaker group, a significant difference was found in the /k/ VOT values for stressed and unstressed conditions ($t(70)=2.1$, $p < 0.05$). For Korean speakers, there was also a significant difference in the /k/ VOT values for stressed and unstressed syllables ($t(69)=7.6$, $p < 0.0001$). As noted in Figure 2, the difference in the mean VOT values for /k/ in stressed and unstressed syllables was only 8 ms for English speakers, compared to 39 ms for Korean speakers. The results for word-medial /p/, /t/ and /k/ altogether show that the difference in VOT values for the three stops in stressed and unstressed syllables was greater for Korean speakers than English speakers in general, though the results slightly differed depending on place of articulation of the stops. As was the case in word-initial voiceless stops, the effect of lexical stress on the aspiration of stops in word-medial positions was greater for Korean speakers than English speakers.

3.2. *The Influence of Prosodic Domain on VOT*

Along with the VOT values that vary with stress placement, Figure 2 also

presents how the two speaker groups differ in producing VOT of voiceless stops depending on their positions within a word, given the same condition of stress placement. Korean speakers and English speakers' production showed an opposite pattern, in terms of domain effect on VOT. For English speakers, the mean VOT values for word-initial voiceless stops that occur in stressed syllables were found to be longer than those in word-medial positions. The same was discovered for unstressed syllables as well, except that VOT of /k/ was found to be the same for both word-initial and word-medial positions. In contrast, Korean speakers exhibited an opposite pattern of results both in stressed and unstressed syllable conditions. That is, they produced longer VOTs in word-medial positions than in word-initial positions. This result is contrary to what was hypothesized at the outset that for both speaker groups, stops placed in word-initial position will be produced with longer VOTs than those in word-medial position. A possible explanation for this rather unexpected result is provided in the discussion section.

4. Discussion

In general, as suggested in section 3, the mean VOT of voiceless stops for English speakers was longer than for Korean speakers, except for word-medial /t/ and /k/ in stressed syllables. One possible explanation for shorter VOTs for Korean speakers can be found in previous studies. It is argued in Kim (2008) and Kim (2013) that Korean is currently undergoing a VOT merger between lax and aspirated stops, which involves VOT lengthening for lax stops, and VOT shortening for aspirated stops. As aspirated stops in Korean tend to be realized with less amount of aspiration recently, this sound change in L1 might have influenced Korean speakers' speech in English to lead them to produce word-initial voiceless stops with less aspiration.

It was also argued that for both speaker groups, voiceless stops were produced with longer VOTs in stressed positions than in unstressed positions in all places of articulation. As already mentioned, it has long been acknowledged in the literature that voiceless stops in stressed syllables generally accompany a greater degree of aspiration (Lisker & Abramson, 1967). The

result of this study complies with the previous findings in which stressed syllables are marked by phonetic realization of a stronger aspiration, measured by a longer VOT in this experiment.

Regarding the relationship between VOT and place of articulation of stops, it was pointed out from the results that the backer the place of articulation, the longer the VOT. This relation was confirmed in previous studies as early as in Fischer-Jørgensen (1954). The fact that VOT is conditioned by place of articulation is explained by articulatory reasons. It is argued in Cho & Ladefoged (1999) that because the volume of cavity behind the velar stop is relatively small, it undergoes a greater pressure when produced. Then it might take longer to produce a velar stop, which leads to a longer VOT. Cho & Ladefoged (1999) suggests that this tendency is found cross-linguistically, and the present study showed both English and Korean speakers had longer VOT in the velar stop /k/.

Generally, as mentioned in 3.1., both English and Korean speakers showed a significant difference in the VOT values for stressed and unstressed conditions, with only a few exceptions. However, it was also pointed out that the difference between VOT values for voiceless stops in stressed and unstressed syllables was greater for Korean speakers. The explanation for this result can be twofold regarding absence of stress in Korean. First, as Korean has no lexical stress, Korean speakers might have been more conscious about the presence of lexical stress and paid more attention to stress information than English speakers. This in turn might have led them to produce the stops in stressed syllables with more strength, causing a relatively greater amount of aspiration, hence a longer VOT. (This is not to be confused with the fact that English speakers in most of the conditions produced a longer VOT than Korean speakers; the important point made here is that Koreans produced relatively longer VOTs for voiceless stops in stressed syllables compared to unstressed syllables, hence a greater difference in the VOT values between the two different stress placements.)

It can also be suggested that they tend to compensate lack of ability to realize stress with another phonetic feature, i.e., aspiration. That is, they choose to indicate the difference in stress placement by making a greater

difference in degrees of aspiration. This implies that L2 learners will find a way to distinguish even the words that differ in phonological features that do not exist in their mother tongue. To review the two hypotheses suggested at the beginning, the first states that Koreans are insensitive to lexical stress, while the second states that Koreans would be still sensitive to lexical stress even though lexical stress does not exist in their mother tongue. The results of the experiment correspond more to the second hypothesis in that Korean speakers' speech was even more affected by stress information. The prediction of the second hypothesis was upheld that the difference in the length of VOT in stressed and unstressed syllables in Korean speakers' speech will be greater than English speakers.

The result can also be partly accounted for in terms of different phoneme inventories in the two languages. Unlike English, Korean distinguishes lax, tense and aspirated stops. Although it is suggested in the literature that there is an ongoing sound change in Korean in which aspiration in aspirated stops become shorter, the findings indicate that Korean speakers are still able to produce a wider range of aspiration when they need to distinguish different sounds. Therefore, it can be proposed that L2 learners may find a strategy, from phonological features of their mother tongue, to distinguish L2 words with a phonological feature that does not exist in their mother tongue.

English and Korean speakers' production of English voiceless stops that differ in their prosodic domain also merits discussion. In section 3.2, it was argued that English speakers produced longer VOTs for word-initial voiceless stops than for those in word-medial positions, given the same stress placement. This can be explained with regard to domain-initial strengthening suggested in a number of previous studies (Cho & Keating, 2001; Cho, McQueen, & Cox, 2007; Keating, Cho, Fougeron, & Hsu, 2003). Considering that word-initial positions are regarded domain-initial, it seems natural that English speakers produced more heavily aspirated stops in word-initial positions than in word-medial positions.

However, it is surprising that for Korean speakers, VOT values were in fact longer in word-medial positions, contrary to what previous studies have

shown. That is, the results of this study differ from Cho and Keating (2001) and Jun (1993) that reported VOT of voiceless stops in Korean are longer in domain-initial positions. If Korean speakers show domain-initial strengthening in their mother tongue, they are likely to speak in a similar way when speaking in English. Rather idiosyncratic result of this experiment can be explained in terms of the effect of stress. As no distinct lexical stress exists in Korean, Korean speakers might have had difficulty pronouncing an English word with stress falling on a certain syllable. In this sense, it is likely that they consciously tried to realize the stress rather intentionally when encountering words that carry a stress on their word-medial positions, while English speakers would have done so naturally. This might have led to a longer VOT in word-medial positions for stressed syllables. Therefore, the results propose that patterns of speech exhibited by L2 learners might be different from that of native speakers, especially when they are required to incorporate a new phonological feature in their L2 speech that does not exist in L1.

Then, how should the result of Korean speakers' production of longer VOT in word-medial position be explained when the voiceless stops were followed by unstressed vowels? Though the production of longer VOTs in word-medial stressed syllables could be explained with regard to Korean speakers' dealing with stress, the same kind of explanation cannot hold for unstressed syllables. This part of the results is not clearly accounted for. One speculation could be that Korean speakers' emphasis on stress of the preceding syllable was too strong that it even influenced the production of the unstressed syllable that follows. Further research is necessary on this matter.

5. Conclusion

In this study, we investigated English and Korean speakers' productions of English voiceless stops to examine whether stress and prosodic domain plays a role in VOT. From various stops in the four phonological environments (i.e., word-initial/stressed, word-initial/unstressed, word-medial/stressed and word-medial/unstressed) the length of VOTs was measured

to examine if English and Korean speakers' speech differed in patterns of VOT realization. The findings show that Korean speaker's VOT production is seen to be different from that of English speakers in both factors – stress and domain. First, the difference between VOT values for voiceless stops in stressed and unstressed syllables was greater for Korean speakers, which indicates that L2 learners are sensitive to phonetic cues that are not attested in their mother tongue and may even be more affected by them. Second, while English speakers produced longer VOTs in word-initial positions, Korean speakers produced longer VOTs in word-medial positions. This shows that the same phonological feature may influence native speakers and L2 learners differently.

References

- Antoniou, M., Best, C. T., Tyler, M. D., & Kroos, C. (2011). Inter-language interference in VOT production by L2-dominant bilinguals: Asymmetries in phonetic code-switching. *Journal of Phonetics*, 39(4), 558-570.
- Au, T. K.-f., Knightly, L. M., Jun, S.-A., & Oh, J. S. (2002). Overhearing a language during childhood. *Psychological Science*, 13(3), 238-243.
- Cho, T., & Keating, P. (2009). Effects of initial position versus prominence in English. *Journal of Phonetics*, 37(4), 466-485.
- Cho, T., & Keating, P. A. (2001). Articulatory and acoustic studies on domain-initial strengthening in Korean. *Journal of Phonetics*, 29(2), 155-190.
- Cho, T., & Ladefoged, P. (1999). Variation and universals in VOT: evidence from 18 languages. *Journal of Phonetics*, 27(2), 207-229.
- Cho, T., & McQueen, J. M. (2005). Prosodic influences on consonant production in Dutch: Effects of prosodic boundaries, phrasal accent and lexical stress. *Journal of Phonetics*, 33(2), 121-157.
- Cho, T., McQueen, J. M., & Cox, E. A. (2007). Prosodically driven phonetic detail in speech processing: The case of domain-initial strengthening in English. *Journal of Phonetics*, 35(2), 210-243.
- Flege, J. E. (1991). Age of learning affects the authenticity of voice-onset

- time (VOT) in stop consonants produced in a second language. *The Journal of the Acoustical Society of America*, 89(1), 395-411.
- Hoard, J. E. (1971). Aspiration, tenseness, and syllabication in English. *Language*, 40(1), 133-140.
- Jun, S.-A. (1993). *The phonetics and phonology of Korean prosody*. PhD dissertation, Ohio State University.
- Keating, P., Cho, T., & Fougeron, C. C. Hsu. 2003. Domain-initial articulatory strengthening in four languages. In J. Local, R. Ogden, & R. Temple (Eds.), *Phonetic Interpretation*, (pp. 145-161). New York, NY: Cambridge University Press.
- Kim, M.-R. (2008). "Lax" stops in Korean revisited. *Studies in Phonetics, Phonology and Morphology*, 14(2), 3-21.
- Kim, M. R. (2011a). Native and non-English speakers' VOT productions of stops. *The Linguistic Association of Korea Journal*, 19(1), 97-116.
- Kim, M.-R. (2011b). The relationship between cross-language phonetic influences and L2 proficiency in terms of VOT. *Speech Sciences*, 3(3), 3-11.
- Kim, M.-R. (2012). L1-L2 Transfer in VOT and f0 Production by Korean English Learners: L1 Sound Change and L2 Stop Production. *Journal of the Korean Society of Speech Sciences*, 4(3), 31-41.
- Kim, M.-R. (2013). *Interspeaker variation on VOT merger and shortening in Seoul Korean*. Paper presented at the Proceedings of Meetings on Acoustics.
- Klatt, D. H. (1976). Linguistic uses of segmental duration in English: Acoustic and perceptual evidence. *The Journal of the Acoustical Society of America*, 59(5), 1208-1221.
- Lisker, L., & Abramson, A. S. (1967). Some effects of context on voice onset time in English stops. *Language and Speech*, 10(1), 1-28.
- Oh, M., & Daland, R. (2011). Word-initial stops in Korean and English monolinguals and bilinguals. *Linguistic Research*, 28(3), 625-634.

ABSTRACT

Native and Non-Native English Speakers' Production of Voiceless Stops: Effects of Lexical Stress and Prosodic Domain on VOT

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This study investigates English and Korean speakers' productions of English voiceless stops to examine whether lexical stress and prosodic domain affect length of voice onset time (VOT). From voiceless stops in four phonological environments, i.e., word-initial/stressed, word-initial/unstressed, word-medial/stressed and word-medial/unstressed, the length of VOT was measured to examine if English and Korean speakers' speech differed in patterns of VOT realization. It was observed that Korean speaker's VOT production was different from that of English speakers with respect to both lexical stress and prosodic domain. First, the difference between VOT values for the stops in stressed and unstressed syllables was greater for Korean speakers. This indicates that L2 learners show sensitivity to phonetic cues that are not attested in their mother tongue and may even be affected by them to a greater degree than native speakers. In addition, while English speakers produced longer VOTs in word-initial positions, Korean speakers produced longer VOTs in word-medial positions. The findings show that the same phonological feature may influence native speakers and L2 learners differently.

Key Words English voiceless stops, voice onset time, L2 learners, lexical stress, prosodic domain