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The Production of Stops by Seoul and Yanbian Korean Speakers

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ABSTRACT

This study investigates dialectal differences in the acoustic properties of Korean lenis, aspirated, and tense stops Seoul Korean (standard Korean) and Yanbian Korean (spoken in the largest Korean Autonomous Prefecture in China). This production study the main acoustic cues that each dialect uses to mark the laryngeal distinction between the three types of Korean stops. Measurements included VOT, and the initial F0 of the following vowel. Data collected from 10 young Seoul Korean speakers, 10 young Yanbian Korean speakers, and 6 older Yanbian speakers. two key findings: First, aspirated and lenis stops are mainly differentiated by F0 in Seoul Korean, and by H1*-H2* in Yanbian Korean. Second, there is no VOT merger between lenis and aspirated stops in Yanbian Korean, whereas there is in Seoul Korean. These results are discussed in terms of the phenomenon of VOT shift and the function of F0t is argued that the function of F0 to substitute for VOT difference as a primary cue for the coding of laryngeal contrast can be predicted by the pitch accent system of the language involved.

Keywords: Korean stops, Seoul Korean, Yanbian Korean, acoustic cues, VOT shift, H1*-H2*, F0 function

1. Introduction

Keating (1984) claims that while voiceless stops can be phonologically specified by the [-voice] feature across languages, their phonetic realization is language-specific, and thus that there is likely to exist a phonetic grammar distinct from the phonology. Furthermore, many researchers maintain that although some contrast categories, such as /p, b, p^h/, are phonologically stable, their phonetic correlates vary both crosslinguistically and, within a single language, contextually (Keyser and Stevens, 2006; Kingston and Diehl, 1994; Ito and Kenstowicz, 2009a).

In most languages, the laryngeal properties of stops are differentiated mainly based on voicing and aspiration (Lisker and Abramson, 1964; Klatt, 1975; Keating, 1984; Ladefoged and Maddieson, 1996). Korean stops, however, are atypical not only in that they exhibit a three-way laryngeal distinction－tense, lenis, and aspirated－but also in that each of these three stops is voiceless in the accentual-phrase-initial position (Jun, 1992; Cho et al., 2002). Furthermore, both phonologically lenis and phonologically aspirated stops are realized as aspirated in Korean (Silva, 2006).

The majority of research in this area has explored the acoustic characteristics of these stops in Seoul Korean. Yet given that voiceless stops can differ phonetically across languages despite being phonologically specified with the same feature (Keating, 1984; Cho and McQueen, 2005), we need to investigate how Korean stops vary in terms of their precise phonetic implementation across multiple dialects. A few studies have investigated dialectal variation in Korean stops (Holliday and Kong, 2011; Cho, 2004). For example, Holliday and Kong (2011) report that Daegu Korean speakers' lenis stops have shorter voice onset times (VOTs) than those of Seoul and Jeju Korean speakers. However, most studies on dialectal variation in Korean stops have been limited to dialects on the Korean peninsula.

This study closely examines how the realization of phonologically identical categories differs acoustically across

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dialects by comparing the acoustic properties of the three Korean stops between Seoul Korean (standard Korean) and Yanbian Korean (the dialect spoken in the largest Korean Autonomous Prefecture of China).[3] Specifically, through this study, we aim to investigate the main acoustic cues used in each dialect to distinguish between the three stops. Many previous studies report that Seoul Korean speakers minimize VOT difference between lenis and aspirated stops, instead relying on fundamental frequency (F0) to differentiate them (Silva, 2006; Wright, 2007). Then, a question arises concerning whether young Yanbian Korean speakers also exhibit similar sound changes to those young Seoul Korean speakers are undergoing with respect to the acoustic realization of stops.

The effect of lexical pitch accent contrast on phonation contrast in stops (Kingston, 2011; Kenstowicz and Park, 2006; Lee and Jongman, 2012) has also attracted our attention. The pitch accent system of a language can affect the possibility that F0 differences can trigger phonation contrasts between stops. For example, Kenstowicz and Park's (2006) study shows that (non-tonal) Seoul Korean employs F0 as the primary cue for the differentiation of lenis from aspirated stops when VOT merger has occurred between them. However, they found that in (tonal) Kyungsang Korean, VOT merger between lenis and aspirated stops does not occur and F0 plays a limited role in laryngeal contrast. Yanbian Korean is tonal (Ito and Kenstowicz, 2009b). Then this study can deepen our understanding of the effect of pitch accent system on the acoustic correlates of stops.

To investigate Korean stops in Seoul and Yanbian Korean with respect to VOT shift and the function of F0, we analyze the production of Korean stops by 10 young Seoul Korean speakers and 10 young Yanbian Korean speakers. Silva (2006) suggests diachronic shift as an explanation for the VOT merger in Seoul Korean. Thus, Korean stops produced by six older Yanbian Korean speakers will also be examined, to investigate whether different patterns of VOT merger by generation, which are seen in Seoul Korean, are also exhibited in Yanbian Korean.

The remainder of this paper is structured as follows. Section 2 provides a general overview of the phonetic characteristics of Korean stops. In section 3, the design and results of the production experiment are presented. Section 4 discusses our findings in light of the phenomena of contrastive VOT shift and functional shift of F0, and then concludes the paper.

2. Phonetic properties of stops in Seoul and Yanbian Korean

Seoul Korean has a three-way phonemic contrast among voiceless stops: lenis, aspirated, and tense. These stops differ from each other in various ways along their acoustic and articulatory dimensions. For example, VOT in the phrase-initial position in Korean is longest in aspirated stops, shorter in lenis stops, and shortest in tense stops (Lisker and Abramson, 1964; Kim, 1965; Han and Weitzman, 1970; Abramson and Lisker, 1972; Hardcastle, 1973; Dart, 1987; Shimizu, 1996; Cho et al., 2002). In addition, findings from fiberscopic and cineradiographic studies indicate that glottal aperture during oral closure in Korean is at its narrowest in tense stops, intermediate in lenis, and widest in aspirated stops (Kim, 1970; Hirose et al., 1974; Kagaya, 1974; Jun et al., 1998).

However, many studies have reported that Korean VOT values have changed over time. For example, Han (1998) claims that VOTs for aspirated and lenis stops have increased over time, based on a review of the literature on Korean VOTs over the past 50 years. Similarly, while the Seoul speakers in their late 50s and early 60s in Cho et al. (2002) do not show any VOT merger, more recent acoustic studies on Korean stops report that young Korean speakers exhibit VOT merger between aspirated and lenis stops (Silva, 2006; Wright, 2007; Oh and Daland, 2011).

Mean F0 is lowest for vowels following lenis stops, higher for vowels following tense stops, and highest for vowels following aspirated stops (Han and Weitzman, 1970; Kagaya, 1974; Kim, 1994; Cho, 1996; Han, 1996; Shimizu, 1996; Kim, 2000). These different F0 patterns result from the different ways in which these stops are produced. Specifically, as shown by results from aerodynamic studies, peak oral pressure during closure is smaller for lenis stops than for tense and aspirated stops (Cho et al., 2002). It is interesting to note that in contrast to the findings on VOT, F0 patterns at the onset of the vowels following each of these three types of stops have not changed over time (Silva, 2006). In contemporary Korean, aspirated and lenis stops are not differentiated from each other by VOT, and the distinction between them has come to be marked instead primarily by F0 difference in the following vowels (Silva, 2006; Wright, 2007).

The phonological contrast between stops we are discussing can

3) The Korean that is spoken in Yanbian used to conform to the standard of Pyeongyang Korean, the main dialect of North Korea; however, since the 1988 Seoul Olympics, the official standard for Korean in China has been South Korean (Park, 2003).

be realized differently depending on whether the dialect of interest is tonal or nontonal. Kenstowicz et al. (2006) explored the role of F0 in distinguishing the three-way stop contrast between tonal and nontonal dialects of Korean, finding that F0 does not play a role in distinguishing the three types of stops in Kyungsang Korean, a tonal dialect, since in this case F0 also functions to code lexical tone. However, F0 was found to be available for the expression of laryngeal contrast in Chonnam and Seoul Korean, which do not carry lexical tonal contrast. Lee and Jongman (2012) also report that in contrast to Seoul Korean, where F0 is significantly different among the three classes of stops, F0 is not a reliable acoustic cue for South Kyungsang speakers. However, the VOT distinction for South Kyungsang still maintains a clear separation between the stops.

Abberton's (1972) laryngographic study reports that the onset of the vowel following a tense stop has some characteristics of creaky voice, specifically its low opening and long closed phase. In contrast, vowels after lenis stops have been found to have a breathy voice (Han, 1998). H1-H2, or the difference between the first and second vocal harmonics, is a good indicator of the voice quality of stops. Cho et al. (2002) found that in Seoul Korean, the three types of stops differ significantly in terms of H1-H2. Specifically, H1-H2 on the following vowel is greatest for lenis stops, intermediate for aspirated stops, and smallest for tense stops, which suggests that vowel onset has breathy voice after lenis stops, and creaky voice after tense stops. Lee and Jongman (2012) found no dialectal variation in the use of the H1-H2 cue between Seoul Korean and South Kyungsang Korean. In other words, H1-H2 does not function to differentiate the three Korean stops of Seoul Korean from those of South Kyungsang Korean.

As in Seoul Korean, Yanbian Korean also has three voiceless stops: lenis, aspirated, and tense. Compared to the volume of work on Seoul Korean stops, relatively few studies have investigated the Korean stops produced by Korean-Chinese populations. Jin (2008) reports that the VOTs for aspirated and lenis stops produced by Korean-Chinese living in Shenyang in northeastern China are merged among young speakers in the same way as in Seoul Korean, and in addition that F0 plays a dominant role in distinguishing these stops. Zheng and Li's (2005) phonetic study on Yanbian Korean stops found that the VOT of lenis stops in Yanbian Korean was rather similar to that of tense stops. This finding is supported by Ito and Kenstowicz (2009a), who maintain that Yanbian Korean shows VOT merger between tense and lenis stops and that F0 does not differentiate these two categories. They claim that it is voice quality, as indicated by H1-H2, that acts as the crucial cue to differentiate between stops in this case.[4] However, the acoustical results in their study were based on the stop production by only a single female Yanbian Korean speaker in her 30s. Yanbian Korean is a pitch accent dialect that developed from the Hamkyung dialect, which is spoken in eastern North Korea (Ito and Kenstowicz, 2009b; Park, 2003). Kang and Han (2012) investigated stops produced by speakers of Hamkyung dialect living in Qingdao. They found that Hamkyung speakers, like the Yanbian speaker studied by Ito and Kenstowicz (2009a), produced lenis stops closer to tense than to aspirated stops. However, the mean age of the subjects in their study was 61 years. Given that Korean speakers from different generations may exhibit different acoustic realizations of stops, there is a need to conduct a phonetic study of stops as produced by a greater number of young Yanbian Korean speakers. In addition to doing so, this study also analyzes stop production by older Yanbian Korean speakers in order to compare stop VOT patterns between young and old speakers.

Our research questions in this study are as follows. First, what are the primary acoustic cues determining the three-way contrast of stops in Seoul Korean and in Yanbian Korean? Second, is there any diachronic VOT shift in stops in Yanbian Korean? Third, is F0 a correlate of the laryngeal contrast in Yanbian Korean stops? By conducting a production experiment among Seoul and Yanbian Korean speakers, we will investigate those questions and compare stops in Seoul and Yanbian Korean with respect to VOT shift and the function of F0.

3. A production experiment using Korean stops produced by Seoul and Yanbian Korean Speakers

3.1 Subjects

A total of 26 speakers of Korean participated in this study: 10 Seoul Korean speakers in their 20s (five males and five females), ten Yanbian Korean speakers who were also in their 20s (five males and five females), and six older Yanbian Korean speakers in their 50s (three males and three females). All the Seoul Korean speakers were college students living in Seoul. All the Yanbian Korean speakers lived in the Yanbian Korean Autonomous Prefecture of China, specifically in the city of Yanji in Jilin Province, at the time of recording. Their first language was Korean and their second, Chinese. They had attended

4) Kim (2009) also investigated the acoustic properties of obstruents in Yanbian Korean without reporting on H1-H2 values of vowel onset following stops.

Korean-language primary and middle schools. They usually spoke Korean in their daily lives, using Chinese only when talking with people who could not understand Korean. The parents of both the young and the old subjects were from Hamkyeung Bukdo Province in the eastern part of North Korea.

3.2 Stimuli and procedure

The target stops, /t, th, t*, k, k^h, k*, p, p^h, p*/, were placed in the word-initial position. The subjects were instructed to read the Korean words /pal/, /p^hal/, /p*al/, /tal/, /t^hal/, /t*al/, /kal/, /k^hal/ and /k*al/ in a carrier sentence, *iketto* _____ *ita* 'this is also ____', three times at a comfortable speaking rate. The stimuli included nonsense words and were not separated into high-tone-initial and low-tone-initial words (cf. Kang and Han, 2012; Ito and Kenstowicz, 2009a). The sentences were randomized and appeared on a computer monitor in front of subjects running K-Alvin (v. 1.27). The utterances were digitally recorded as WAVE files. A total of 702 productions were collected (9 Korean words x 3 repetitions x 26 subjects). The recordings of the Seoul Korean speakers were made in a sound-attenuated room at Korea University in Seoul, and those for Yanbian Korean speakers, in a quiet room at Yanbian University in Yanji. The stimuli were analyzed using the software packages Praat (v. 5.2.26) and VoiceSauce (v. 1.08, Shue, Keating, Vicenik, and Yu, 2011).

3.3 Measurements

Three acoustic cues were measured for each target word-initial CV unit: VOT, F0, and H1*-H2*.[5] VOT was measured from the beginning of the stop burst to the first full glottal pulse of the vowel onset. The VoiceSauce software package provided values for F0 and H1*-H2* at every 1/9 point during the vowel. Nine points in the time course can be divided into three parts. The 2/9 point of the vowel is the middle of the first part and is considered to be the appropriate point to show the quality of the vowel. Thus, the F0 and H1*-H2* values adopted for analysis were taken at the 2/9 point of the vowel. We discarded four tokens (one from each dialect and gender group) due to extreme values after segmentation. SPSS (v. 16.0) was used for statistical analysis.

5) H1*-H2* is a corrected measure that takes differences in formant positions into account.

3.4 Results

3.4.1 A summary of VOT, F0, and H1*-H2* results

To give an overview of the most important aspects of the data, the mean values of VOT (in ms), H1*-H2* (dB), and F0 (Hz) for the three types of Korean stops as produced by the 10 Seoul Korean speakers and the 10 young Yanbian Korean speakers are shown in Table 1, with the standard errors also provided (in parentheses).

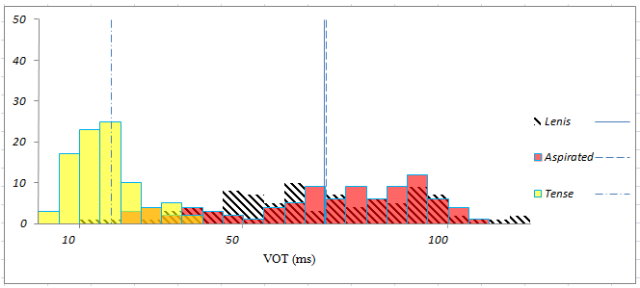
<Table 1> Mean values of VOT, H1*-H2*, and F0 for Korean stops (young)

Stop type	Measure	Seoul Korean		Yanbian Korean	
		Female	Male	Female	Male
Lenis	VOT (ms)	70 (22.3)	69 (24.2)	15 (5.7)	16 (8.6)
	H1*-H2* (dB)	11.9 (4.7)	10 (2.8)	6.4 (3.9)	7.1 (1.8)
	F0 (Hz)	212 (15.7)	121 (16.7)	260 (41.3)	136 (9.8)
Aspirated	VOT (ms)	63 (23.2)	81 (18.2)	96 (13.1)	77 (25.5)
	H1*-H2* (dB)	8 (9.7)	11.2 (2.8)	6.8 (2.8)	8.8 (2.8)
	F0 (Hz)	302 (32.5)	157 (17.3)	287 (34)	146 (13.5)
Tense	VOT (ms)	14 (4.8)	20 (8.7)	10 (3.4)	12 (6.8)
	H1*-H2* (dB)	3.9 (4)	5.1 (2.5)	-.16 (2.6)	1.7 (1.3)
	F0 (Hz)	276 (23.9)	144 (10.5)	259 (46)	142 (8.5)

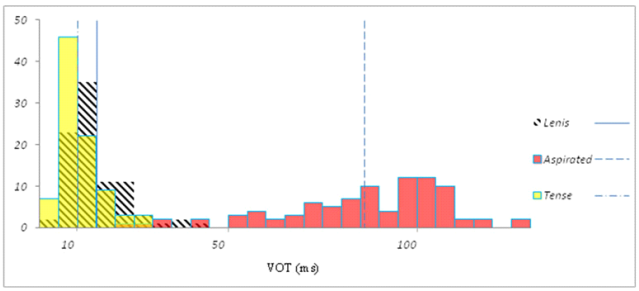
These results indicate that lenis stops in Seoul Korean are clearly different from those in Yanbian Korean with respect to VOT and F0. The VOT of lenis stops in Seoul Korean is much higher than that in Yanbian Korean, whereas the F0 of lenis stops in Seoul Korean is lower than that in Yanbian Korean. In the following section, we examine these results more closely in terms of the three acoustic features that are important to our study.

3.4.2 Voice onset time (VOT)

Figure 1 shows the VOT distribution of lenis, tense, and aspirated stops produced by (young) Seoul Korean and young Yanbian Korean speakers.



a. Seoul Korean (young)



b. Yanbian Korean (young)

Figure 1. VOT of stops

The vertical lines in Figure 1 indicate the mean VOT for each stop category. The overlapping parts indicate the distribution of each stop category according to their number and values. In Seoul Korean, the mean VOTs of both lenis and aspirated stops are very long, whereas the mean VOT of tense stops is quite short. In contrast, in Yanbian Korean, the mean VOTs of both lenis and tense stops are much longer than those of aspirated stops.

The results of a one-way ANOVA indicate that VOT functions to differentiate these stops: F(2,266)=233.95, p=.001 in Seoul Korean and F(2,266)=843.58, p=.000 in Yanbian Korean. Specifically, a post-hoc test of the one-way ANOVA results for each group showed that the VOT does not differentiate lenis and aspirated stops in Seoul Korean [F(2,266)=233.95, p=.38], while it does in Yanbian Korean [F(2,266)= 843.58, p=.000]. On the other hand, VOT differentiates lenis and tense stops in Seoul Korean [F(2,266)=233.95, p=.000] but not in Yanbian Korean [F(2,266)= 843.58, p=.11].

Silva (2006) conducted a cross-sectional study of stop VOT in Korean in which participants were grouped by age. The results demonstrate VOT change over time in Korean stops. Speakers born prior to 1965 exhibit a robust separation between the lenis and aspirated categories, whereas VOTs for these categories are completely merged in speakers born after 1975. In other words, speakers aged over 50 have a conservative variant with longer VOTs for aspirated stops than for lenis stops, while speakers under 30 show an innovative variant in which there is a single VOT target for both these long-lag stops. The finding was also supported by Kang and Guion (2006; 2008). Both Silva (2006) and Kang and Guion (2006; 2008) focused on the production of Korean stops by Korean speakers living in America. However, Oh and Daland (2011) report that VOT merger between lenis and aspirated stops also occurs among Seoul Korean speakers living in Seoul, Korea.

In contrast to speakers of Seoul Korean, young Yanbian Korean speakers do not exhibit VOT merger between lenis and aspirated stops. However, t-test results demonstrate that the VOTs of both lenis (t=-3.5, p=.004) and aspirated stops (t=-6.9, p=.000) among Yanbian speakers show a significant decrease over time. This is illustrated in Figure 3, which compares VOTs between the 10 young and six older Yanbian Korean speakers.

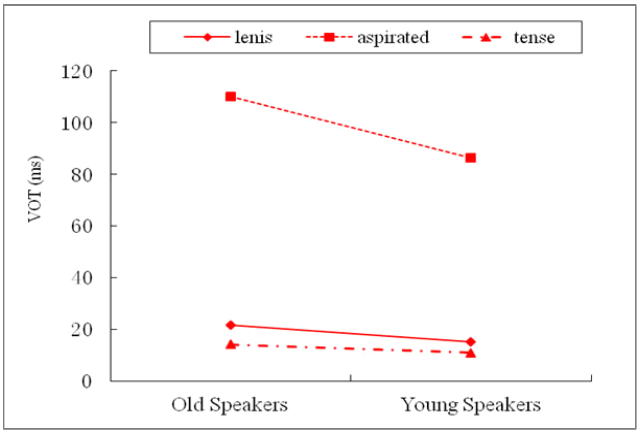


Figure 2. VOT of stops by young and old Yanbian Korean speakers

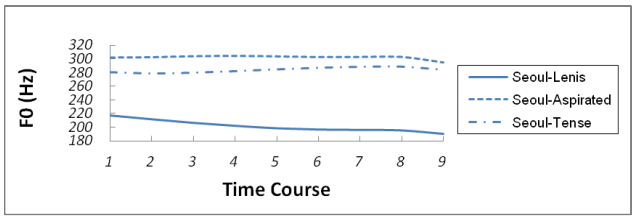
As in Seoul Korean (Silva 2006), VOT for aspirated stops in Yanbian Korean is decreasing over time. In other words, the VOT for aspirated stops produced by young Yanbian Korean speakers is significantly shorter than that for older Yanbian Korean speakers (t=-6.9, p=.000). However, in contrast to Seoul Korean, the VOT of lenis stop is also decreasing in Yanbian Korean.

3.4.3 Fundamental frequency (F0)

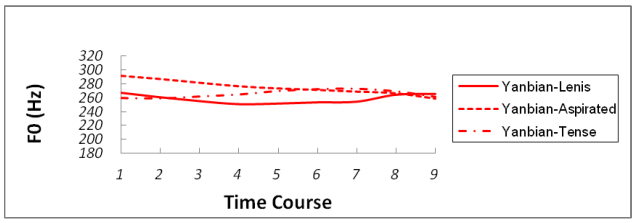
F0 values at the 2/9 point of the vowels following stops in each of the three categories were examined by one-way ANOVA. We analyzed the data from male and female speakers separately, since absolute F0 values differ by gender. In Seoul Korean, a significant difference was found between the stop categories for both female speakers [F(2,132)=157.95, p=.000] and male speakers [F(2,132)=67.05, p=.000]. Post-hoc comparison indicated that there was a significant difference between lenis and aspirated stops (female: p=.000, male: p=.000), which is in line with the results from Cho et al. (2002). The mean F0 for words beginning with lenis stops was significantly lower than that for comparable words beginning with aspirated stops.

In Yanbian Korean, a significant difference was found between stop categories for male speakers only [F(2, 132)=9.13, p=.000]. Specifically, post-hoc comparison indicated that a significant difference was found between tense and lenis stops for male

speakers (F(2,132)=9.13, p=.000) but not for female speakers (F(2,132)=6.62, p=.98). The following figure shows F0 time course patterns throughout the vowels after stops for female speakers of both Seoul and Yanbian Korean.



a. Seoul Korean (young)



b. Yanbian Korean (young)

Figure 3. F0 at nine points of the vowels following stops for female speakers

As shown in Figure 3a, in Seoul Korean, F0 values toward the beginning part of the vowel are separated depending on the stop they follow, and the distance among them is maintained throughout the time course. In Yanbian Korean, in contrast, F0 values for the three stop categories merger at the end of the time course, as shown in Figure 3b. Furthermore, as indicated by Figure 4, F0 for lenis stops in Seoul Korean is much lower than in Yanbian Korean.

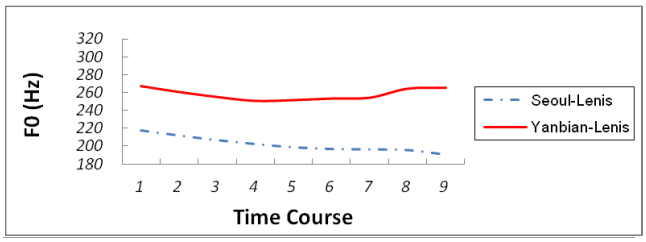
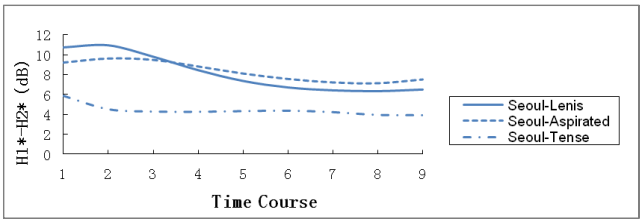


Figure 4. Time course of F0 after lenis stops in Seoul and Yanbian Korean (young)

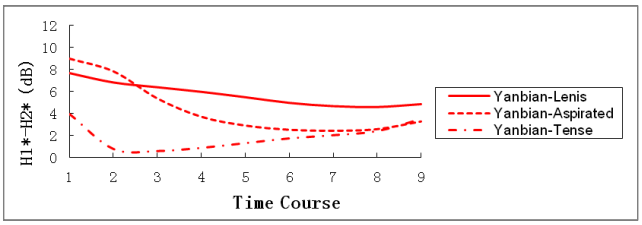
To summarize, lenis stops in Seoul Korean are very different from those in Yanbian Korean with respect to VOT and F0. Lenis stops in Seoul Korean are characterized by a long VOT and a low F0, whereas those in Yanbian Korean show a short VOT and a high F0.

3.4.4 Voice quality (H1*-H2*)

In this section we report H1*-H2* results provided by the VoiceSauce software package for H1*-H2*. By measuring H1*-H2* at the 2/9 point of the vowel following each of the three types of stop, we could determine the phonation types of the stops. In this part of the study, the data for females and males were combined.[6] Figure 5 demonstrates the H1*-H2* time course patterns for all the speakers of each dialect.



a. Seoul Korean (young)



b. Yanbian Korean (young)

Figure 5. H1*-H2* time course

As shown in Figure 5a, for Seoul Korean speakers, H1*-H2* starts higher at the onset of the vowel following a lenis stop than following an aspirated stop, whereas H1*-H2* for lenis stops begins to decrease at the 3/9 point. Furthermore, the H1*-H2* values for lenis and aspirated stops are very close to each other at the end of the time course. In Yanbian Korean, in contrast, as shown in Figure 5b, H1*-H2* starts higher at the onset of the vowel following an aspirated stop than following a lenis stops. However, H1*-H2* for aspirated stops begins to drop at the 3/9 point, and H1*-H2* values for aspirated and tense stops are very close to each other at the end of the time course. In contrast, H1*-H2* values for lenis and tense stops remain quite separate throughout the vowel.

The one-way ANOVA results for H1*-H2* measures at the 2/9 point of the vowel support the observations mentioned above.

6) As for H1*-H2* of lenis stops, female Seoul Korean speakers have breathier voices than male Seoul Korean speakers, but for aspirated stops, male Seoul Korean speakers have breathier voices than their female counterparts. Because of this inconsistency, we combined H1*-H2* values of female and male speakers in this study.

There was no significant difference between lenis and aspirated stops in Seoul Korean [$F(2,266)=38.83$, $p=.181$] but a significant difference between lenis and tense stops was found [$F(2,266)=38.83$, $p=.000$]; in Yanbian Korean, in contrast, a significant difference was observed between lenis and aspirated stops [$F(2,266)=166.24$, $p=.034$] and also between lenis and tense stops [$F(2,266)=166.24$, $p=.000$].

4. Discussion and conclusion

This study investigated three acoustic cues in order to differentiate the typologically unusual three-way laryngeal contrast in Korean stops in terms of those cues. We compared three stop categories—tense, lenis, and aspirated—between Seoul Korean and Yanbian Korean with respect to VOT, F0, and H1*-H2*, and found that Seoul Korean speakers differ systematically from Yanbian Korean speakers in terms of the fine-grained phonetic implementation of these different stops.

In Seoul Korean, the VOTs for lenis and aspirated stops are merged. We also found a difference in voice quality between stops, namely creakiness on the following vowel, indicated by low H1*-H2*, in tense stops and breathiness on that vowel, indicated by high H1*-H2*, for lenis and aspirated stops (Cho et al., 2002). H1*-H2* also distinguishes between lenis and tense stops across both genders in Seoul Korean. Furthermore, we found significantly higher F0 for tense and aspirated stops than for lenis stops in Seoul Korean.

In Yanbian Korean, in contrast, VOTs for lenis stops were the same as for tense stops (Zheng and Li, 2005; Ito and Kenstowicz, 2009a). Only male Yanbian speakers exhibited higher F0 for tense stops than for lenis stops. Yet H1*-H2* clearly distinguishes between lenis and tense stops across both genders in Yanbian Korean (Ito and Kenstowicz, 2009a). Specifically, H1*-H2* for the vowel following a lenis stop is significantly higher than that following a tense stop.

These results can be summarized as constituting three key findings. First, different VOT merger patterns were found across these two dialects of Korean. VOT was formerly a sufficient cue for the three-way phonemic contrast in Seoul Korean stops (Lisker and Abramson, 1964), but VOT values for lenis and aspirated stops have merged in contemporary Seoul Korean (Silva, 2006). In contrast, VOTs for lenis and aspirated stops remain distinct for young Yanbian Korean speakers. However, VOT for lenis stops is as short as that for tense stops; that is to say, whereas Seoul Korean exhibits VOT merger between lenis and aspirated stops, in Yanbian Korean VOT does not differentiate lenis and tense stops.

Second, the major cue for distinguishing between the three stop categories differs between Seoul Korean and Yanbian Korean. In Seoul Korean, VOT and H1*-H2* do not differentiate lenis and aspirated stops, whereas F0 plays a crucial role. In contrast, in Yanbian Korean, VOT does not act as the primary cue to distinguish lenis and tense stops for both genders and F0 does not play a role in differentiating lenis and tense stops for female speakers, a role assigned instead to the relative breathiness of the following vowel, as indicated by H1*-H2*.

Third, it was found that F0 is a crucial cue in stop identification in Seoul Korean but only plays a limited role in Yanbian Korean. This study showed that F0 does not distinguish tense and lenis stops in Yanbian Korean as was found in previous studies (Kang and Han, 2012; Kim, 2009).[7)]

At this point, we need to discuss the question of how much the pitch accent system of a language affects the possibility that F0 differences can trigger phonation contrasts between stops. There are two contrastive views on tonogenesis due to preceding consonants. The first is that taken by Kingston (2011), who argues that the perturbations induced by laryngeal articulations of initial consonants does not lead to the development of contrastive tone in non-tonal languages. Kingston suggests that speakers of tonal languages are sensitive to F0 differences between previously existing tones and as a result are more likely to attend to systematic F0 differences after consonants. If we accept this view, tonogenesis in the non-tonal dialect of Seoul Korean needs to be treated as an exception to the generalization.

The second view is found in Kenstowicz and Park (2006) and Lee and Jongman (2012), who claim that systematic F0 differences after initial consonants are not generally constrained in non-tonal languages and thus that preceding consonants are likely to trigger tonogenesis in these contexts. Kenstowicz and Park (2006) suggest instead that since Seoul Korean is a nontonal dialect, F0 can be taken as the primary cue for the differentiation of lenis from aspirated stops when VOT merger has occurred between them. In contrast, in Kyungsang Korean, which is tonal, F0 performs a dual phonological function; that is, it expresses both lexical-tonal contrast among vowels and laryngeal contrast among stops. In contrast to the Seoul dialect, the Kyungsang dialect does not exhibit VOT merger between lenis and aspirated stops, and F0 plays a limited role in laryngeal contrast in

7) Kim's (2009) study did not take the different pitch accents of stimuli into consideration.

Kyungsang dialect (Kenstowicz and Park, 2006). Kenstowicz and Park (2006) suggest that H1-H2 may function as a possible compensating factor for F0 on the basis of the big difference in H1-H2 values among the three types of stops in Kyungsang Korean as compared to Seoul Korean (a difference that they assert based on Cho et al. (2002), since they themselves did not conduct a stop production experiment among Seoul Korean speakers). Thus, a comparison between Seoul and Yanbian Korean supports the second view of tonogenesis due to preceding consonants mentioned above, which attributes it to the interrelation between F0's function in laryngeal contrasts across tonal vs. nontonal dialects.

Another argument for the second view comes from a comparison of the function of F0 between different dialects of Korean spoken in China. The Shenyang dialect of Korean is non-tonal and exhibits a similar pattern to Seoul Korean wherein VOT overlaps between lenis and aspirated stops and F0 functions to distinguish them (Jin, 2008). In contrast, Yanbian Korean is tonal (Ito and Kenstowicz, 2009b). The acoustical results from our study of Yanbian Korean demonstrate that there is no VOT merger between lenis and aspirated stops but also that VOT does not differentiate lenis and tense stops. However, F0 does not function to differentiate lenis and tense stops, a role instead assigned to H1*-H2*. Thus, the results of this study support the second view—that F0 function, as a primary cue for stop identification, is correlated with whether the variety being investigated is tonal or non-tonal.

In this study, we investigated the production of Korean stops between different dialects of the language. Future work needs to test the perceptual relevance of the correlates we identified in each dialect and the degree to which they interact with each other in perception.

References

Abberton, E. (1972). Some laryngographic data for Korean stops. *Journal of International Phonetic Association*, 2(2), 67-78

Abramson, A. S. & Lisker, L. (1972). Voice timing in Korean stops. *In Proceedings of the VIIth International Congress of Phonetic Sciences,* 439-446. The Hague: Mouton.

Cho, M. (2004). *An acoustical study of the stops of the Seoul and Daegu dialects.* M.A. Thesis, Korea University.

Cho, T. (1996). *Vowel correlates to consonant phonation: an acoustic-perceptual study of Korean obstruents.* M.A. Thesis, University of Texas at Arlington.

Cho, T., Jun, S. & Ladefoged, P. (2002). Acoustic and aerodynamic correlates of Korean stops and fricatives. *Journal of Phonetics,* 30(2), 193-228.

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.

Dart, S. N. (1987). An aerodynamic study of Korean stops consonants: measurements and modeling. *Journal of the Acoustical Society of America,* 181(1), 138-147.

Han, J. I. (1996). *The phonetics and phonology of 'tense' and 'plain' consonants in Korean.* Ph.D. Dissertation, Cornell University.

Han, M. S. & Weitzman, R. S. (1970). Acoustic features of Korean /P, T, K/, /p, t, k/ and /ph, th, kh/. *Phonetica,* 22(2), 112-128.

Han, N. (1998). *A comparative acoustic study of Korean by native Korean children and Korean-American children.* M.A. Thesis, UCLA.

Hardcastle, W. J. (1973). Some observations on the tense-lax distinction in initial stops in Korean. *Journal of Phonetics,* 1, 263-272.

Hirose, H., Lee, C. & Ushijima, T. (1974). Laryngeal control in Korean stop production. *Journal of Phonetics,* 2, 145-152.

Holliday, J. and Kong, E. (2011). Dialectal variation in the acoustic correlates of Korean stops. *ICPhS XVII*, 878-881.

Ito, C. & Kenstowicz, M. (2009a). Mandarin loanwords in Yanbian Korean I: laryngeal features. *Phonological Studies,* 12, 61-72.

Ito, C. & Kenstowicz, M. (2009b). Mandarin loanwords in Yanbian Korean II: Tones. *Language Research,* 45(1), 85-109

Jin, W. (2008). *Sounds of Chinese Korean: a variationist approach.* Ph.D. Dissertation, University of Texas at Arlington.

Jun, S. (1992). *The Phonetics and Phonology of Korean Prosody,* Ph.D. Dissertation, The Ohio State University.

Jun, S., Beckman, M. & Lee, H. (1998). Fiberscopic evidence for the influence on vowel devoicing of the glottal configurations for Korean obstruents. *UCLA Working Papers in Phonetics,* 96, 43-68.

Kagaya, R. (1974). A fiberscopic and acoustic study of the Korean stops, affricates, and fricates. *Journal of Phonetics,* 2, 161-180.

Kang, K. & Guion, S. (2006). Phonological systems in bilinguals: Age of learning effects on the stop consonant systems of Korean-English bilinguals. *Journal of Acoustical Society of America,* 119(3), 1672-1683.

Kang, K. & Guion, S. (2008). Clear speech production of Korean stops: Changing phonetic targets and enhancement strategies.

Journal of the Acoustical Society of America, 124(6), 3909-3917.

Kang, Y. & Han, S. (2012). *Dialectal variation in Korean plosives.* Ms. Korea.

Keating, P. A. (1984). Phonetic and phonological representation of stop consonant voicing. *Language,* 60(2), 286-319.

Kenstowicz, M. & Park, C. (2006). Laryngeal features and tone in Kyungsang Korean: a phonetic study. *Studies in Phonetics, Phonology, and Morphology,* 12(2), 247-264.

Keyser, S. J. & Stevens, K. (2006). Enhancement and overlap in the speech chain. *Language,* 82(1), 33-63.

Kim, C. W. (1965). On the autonomy of the tensity feature in stop classification (with special reference to Korean stops). *Word,* 21, 339-359.

Kim, C. W. (1970). A theory of aspiration. *Phonetica,* 21(2), 107-116.

Kim, H. (2009). Experimental phonetic study of Yanjin Sino-Korean dialect. *Speech Sciences,* 1, 47-52.

Kim, M. R. (1994). *Acoustic characteristics of Korean stops and perception of English stop consonants.* Ph.D. Dissertation, University of Wisconsin.

Kim, M. R. (2000). *Segmental and tonal interactions in English and Korean: a phonetic and phonological study.* Ph.D. Dissertation, University of Michigan.

Kingston, K. (2011). Tonogenesis. In M. van Oostendorp, C. J. Ewen, E. Hume, & K. Rice (Ed.), *The Blackwell Companion to Phonology.* Blackwell Reference Online. Retrieved from http://www.companiontophonology.com/subscriber/tocnode?id=g9781405184236_chunk_g978140518423699 on June 21, 2012.

Kingston, K. J. & Diehl, R. (1994). Phonetic knowledge. *Language,* 70(3), 419-454.

Klatt, D. (1975). Voice onset time, frication, and aspiration in word-initial consonant clusters. *Journal of Speech and Hearing Research,* 18, 686-706.

Ladefoged, P. & Maddieson, I. (1996). *The sounds of the world's languages.* Oxford: Blackwell Publishers.

Lee, H. & Jongman, A. (2012). Effects of tone on the three-way laryngeal distinction in Korean: An acoustic and aerodynamic comparison of the Seoul and South Kyungsang dialects. *Journal of the International Phonetic Association,* 42, 145-169.

Lisker, L. & Abramson, A. S. (1964). A cross-language study of voicing in initial stops: acoustical measurements. *Word,* 20, 384-422.

Oh, M. & Daland, R. (2011). Word-initial stops in Korean and English Monolinguals and Bilinguals. *Linguistic Research,* 28(3), 625-634.

Park, Y. (2003). A preliminary study of the language of ethnic Koreans in China: Toward a sociolinguistic understanding. *Linguistic Study at Kyoto University,* 22, 1-21.

Shimizu, K. (1996). *A Cross-language study of voicing contrasts of stop consonants in Asian languages.* Tokyo: Seibido Publishing.

Shue, Y., Keating, P., Vicenik, C. & Yu, K. (2011), Voicesauce: a program for voice analysis. *ICPhS XVII*, 1846-1849.

Silva, D. (2006). Acoustic evidence for the emergence of tonal contrast in contemporary Korean. *Phonology*, 23(2), 287-308.

Wright, J. D. (2007). *The phonetic contrast of Korean obstruent.* Ph.D. Dissertation, University of Pennsylvania.

Zheng, X. R. and Li. Y. H. (2005). A contrastive study of VOT of English and Korean stops. *Journal of Yanbian University (Social Science)*, 38(4), 99-102.

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