

VOT MERGER IN HERITAGE KOREAN IN TORONTO*

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Korean has a typologically unusual three-way laryngeal contrast in voiceless stops among aspirated, lenis and fortis stops. Recent studies show that Seoul Korean is undergoing a female-led sound change whereby the aspirated stops and the lenis stops are merging in Voice Onset Time (VOT) and are better distinguished by the F0 (Fundamental frequency) of the following vowel than by their VOT, in younger speakers' speech. This paper examines the VOT pattern of Heritage Korean speakers in Toronto, and finds that the same change is in progress in Toronto, except that younger female speakers do not advance the change, unlike their Seoul counterparts. We consider three possible accounts of the differences between the Seoul and Toronto patterns: two that attribute the difference to the influence of English, a VOT language, and one that attributes the difference to a loss of gender-conditioned variation.

1. Introduction

The *Heritage Language Variation and Change in Toronto* (HLVC, Nagy 2009) project investigates the types of inter-speaker and cross-generational grammatical variation that occur in a set of heritage languages spoken in Toronto, a city where 44% of the population (2.4 million people) count a language other than English as their mother tongue (Statistics Canada 2007). The goals of the project are to better understand what cross-linguistic generalizations are possible about the types of features (or structures, rules or constraints) that are borrowed earlier and more often, and to understand the roles of social factors, at the individual and community levels, in these contact-induced changes. Nagy (2011) describes the goals and methodology in detail.

A primary linguistic variable investigated in the HLVC project is Voice Onset Time (VOT). VOT is defined as the duration of the interval between the release of a stop and the onset of vocal fold vibration for the following vowel. It is a primary cue that distinguishes voiced (indicated by negative or short VOT values) and voiceless (indicated by positive or long VOT values) obstruents in many languages (Lisker and Abramson 1964). VOT is present in all languages and it is particularly susceptible to change due to contact (Flege 1987, Flege and Eefting 1987, Sancier and Fowler 1997, Fowler et al. 2008, Antonio et al. 2010, Chang 2012). In this paper, we examine VOT values of stops in Heritage Korean, a language with the three series of stop consonants shown in (1). The sets of minimal triplets in (1) illustrate the three-way phonemic contrast at each place of articulation. In this paper, we will focus on the cues to the realization of lenis and aspirated stop categories.

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(1) Minimal triplets illustrating the three series of Korean stops

	Fortis (unaspirated)	Lenis (slightly aspirated)	Aspirated (heavily aspirated)
bilabial:	/pʰul/ ‘horn’	/pul/ ‘fire’	/pʰul/ ‘grass’
coronal:	/tʰal/ ‘daughter’	/tal/ ‘moon’	/tʰal/ ‘mask’
velar:	/kʰin/ ‘string’	/kin/ ‘pound’	/kʰin/ ‘big’

The three-way contrast of these stops in Heritage Korean presents a particularly interesting case of variation in a language contact situation. In most cases of stop variation examined in previous language contact studies, the two languages in contact both makes two-way contrast between voiceless/aspirated vs. voiced/unaspirated stops (e.g., contact of English with French, Spanish, Portuguese, Greek, Italian, Dutch, Mandarin, etc.), where a single acoustic dimension of VOT is sufficient to make a binary distinction within a language reliably. The previous studies focus on adjustment of VOT values due to cross-language influence. In contrast, Korean has a three-way laryngeal contrast and VOT alone does not distinguish the stop categories reliably. Instead, a combination of acoustic cues, including voice onset time (VOT) of the stop, and the fundamental frequency (F0) and amplitude difference between the first and the second harmonics (H1-H2) of the following vowel, play a contrastive role (Cho, Jun & Ladefoged, 2002; Hardcastle 1973; Han & Weitzman 1970; Kang & Guion 2008; Kim 1965; Kim 1994). This forces us to look beyond contact effects along a single acoustic dimension and examine how the weighting of multiple cues may be affected by language contact. Moreover, the homeland variety of Korean (in Seoul) is undergoing a sound change in the stop system (see §2) and this allows us to examine if and how an on-going sound change in a homeland variety of a language is transmitted to a heritage variety.

2. Cues for laryngeal contrast in Seoul Korean

Recent studies suggest that Seoul Korean is undergoing a tonogenesis-like sound change: pitch differences are replacing VOT differences as the key cue to a phonemic contrast between word-initial aspirated and lenis stops (Choi 2002, Kim et al. 2002, Kim 2004, Silva 2006, Wright 2007, Jin 2008, Kang and Guion 2008, Kong et al. 2011, Oh 2011, Kang submitted, Kang and Han submitted). Tonogenesis is defined as a process in which consonant-induced pitch perturbation develops into a tonal contrast, eventually replacing the original voicing or phonation contrast of consonants (Hombert, Ohala and Ewan 1979, Thurgood 2002, Kingston 2011). Fig. 1, based on data from Kang (submitted), illustrates the variation of VOT and F0 values by speakers' sex and age in Seoul Korean. The most notable change is the shortening of VOT values for aspirated stops and the concomitant decrease in VOT contrast between lenis and aspirated stops in younger generation of speakers. The female speakers are a whole generation ahead of male speakers in this change. At the same time, the F0 contrast between the aspirated and lenis stops is increased in younger speakers' speech. The study is based on measurements of sentence-initial stops (all nine types) produced by 117 Seoul residents (58 male and 59 female) in a read speech corpus distributed by the National Institute of the Korean Language (NIKL 2005). A total of 1,023 tokens of stops are analyzed.

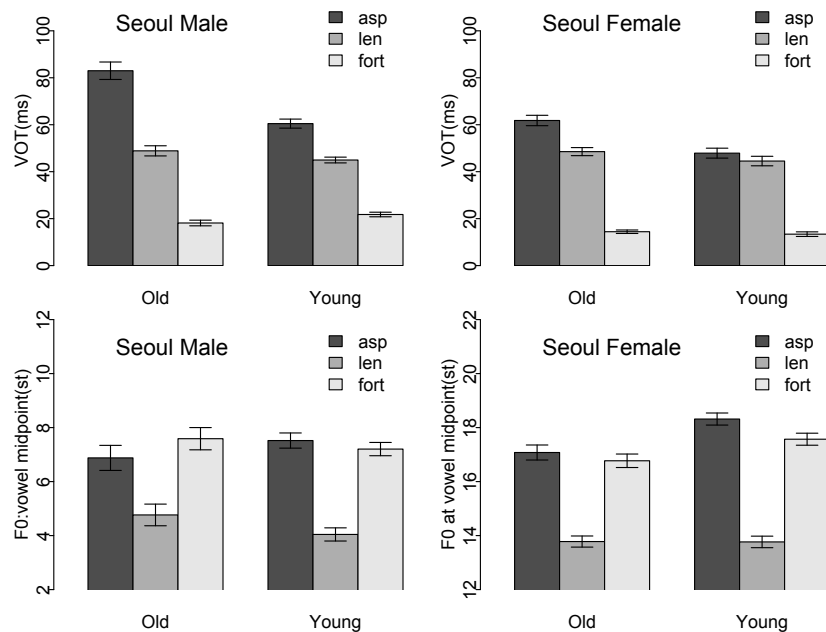


Figure 1: Mean VOT (top row) and mean F0 (bottom row) values for the three series of stops in Seoul Korean for males (left) and females (right) by speakers' age (Old: born before 1962, Young: born after 1962).

Fig. 2 shows the distribution of the aspirated and lenis stops from the same NIKL data plotted in two dimensional acoustic space of VOT by F0. The category boundary is determined by linear discriminant analyses. The plots are created using the *partimat* function in the *klaR* package (Roever et al. 2011) for R (R Development Core Team 2011). The slope of the boundary indicates the relative weighting of the two acoustic cues in distinguishing the two stop categories. For older (born before 1962) male speakers, the boundary is almost vertical indicating that only VOT is contrastive and F0 does not contribute to the contrast significantly. For younger (born after 1962) male speakers, the boundary is diagonal indicating that both VOT and F0 play a role in the stop contrast. For female speakers, both older and younger speaker groups, the boundary is almost horizontal indicating that VOT is **not** a significant cue and that the contrast is signaled mainly by F0. The F0 effect is stronger for younger than older groups. These observations are confirmed by mixed-effects logistic regression analyses (see Kang submitted for more details). Given the differences by age and sex, we surmise that this is a female-led sound change.

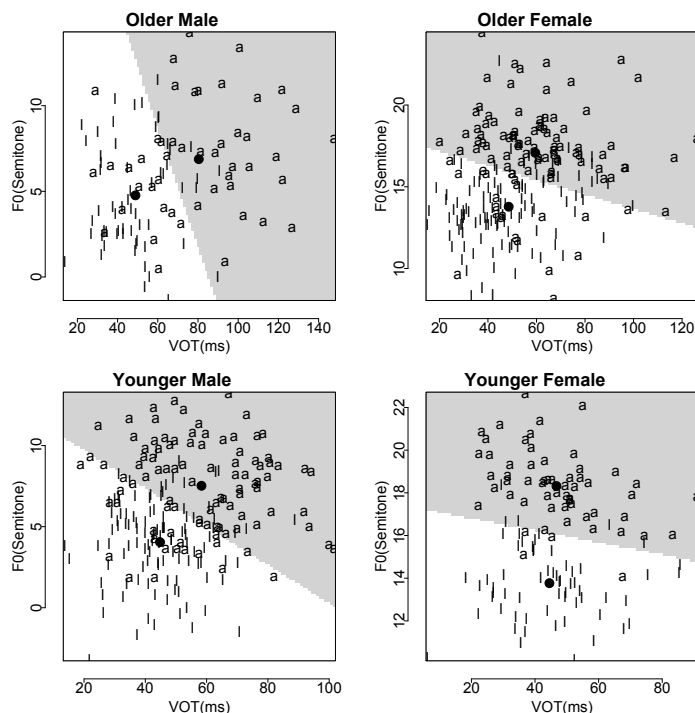


Figure 2: Trading relation between F0 and VOT to contrast lenis (l) vs. aspirated (a) stops by speaker sex and age, Seoul Korean.

3. Language contact effect: English and Korean in Toronto

Given the continued close contact between the Seoul and Toronto varieties, we expect the change to be transmitted and replicated in Heritage Korean in Toronto.¹ We now consider three hypotheses of how contact with English may affect Heritage Korean. In contrast to Korean, English has a two-way laryngeal contrast. It is classified as a long lag VOT language: voiceless stops have VOT values >30 msec and “voiced” stops have short lag or negative VOT values. When we compare the VOT of the two long lag stops of Korean, i.e. aspirated and lenis stops, with those of English voiceless stops, for those speakers who make VOT distinction between the two Korean stop categories, the VOT values of the English stops tend to be intermediate between the two Korean categories (Korean lenis < English voiceless < Korean aspirated), as shown in (2) (Lisker and Abramson 1964). In more recent studies, however, where Korean speakers make less VOT contrast between the two long-lag stop categories, all three stop categories show similar values, also shown in (2) (Kang and Guion 2006).

¹ Jin (2008) found a similar change in progress in Shenyang Korean, a dialect spoken in Shenyang, China that has not been in close contact with Seoul Korean. This opens the possibility that this change occurs in Heritage Toronto Korean independently.

(2) Mean VOT (ms) of Korean and English long lag stops

Source	English Voiceless	Korean Lenis	Korean Aspirated
Lisker & Abramson 1964	p:58 t:70 k:80	p:18 t:25 k:47	p ^h :91 t ^h :94 k ^h :126
Kang & Guion 2006	72	63	68

It is not clear how contact with English should affect the VOT realization of Korean stops in Heritage Korean. First, while many studies of VOT variation under language contact show an assimilatory change in VOT, other studies show lack of assimilatory effect especially in more balanced bilingual speakers (Kang and Guion 2006). The complexity of the situation is well illustrated by the behaviour of other Heritage Languages whose VOT patterns we have previously examined in the HLVC corpus. In Russian and Ukrainian, we see a cross-generational pattern of drift toward English VOT across generations, as in Fig. 3. On the other hand, we did not see any effect in Italian, indicating that this type of drift is neither automatic nor unavoidable in language contact situations.

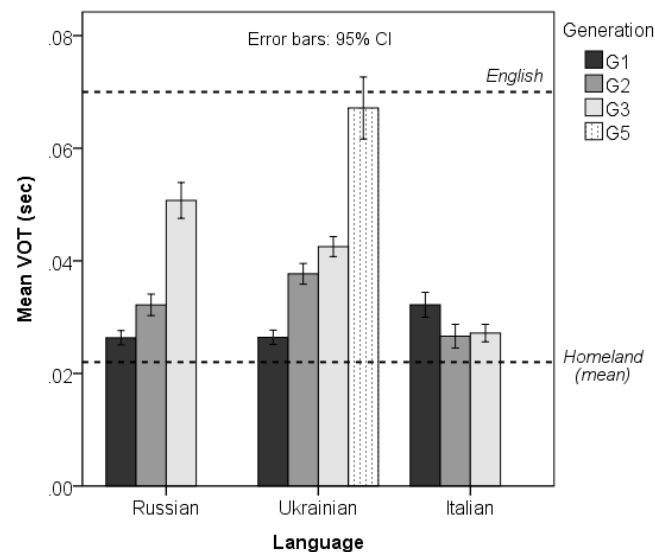


Figure 3: Cross-generation and cross-linguistic comparison of VOT means (from Hrycyna et al. 2011). Homeland data from Ringen and Kulikov 2010, to appear; and Sorianello 1996. (Montreal) English data from Fowler et al. 2008).

Moreover, it is not clear how the three-way contrast of Korean stops and the two-way contrast of English stops are equated. In English loanwords in Korean and in cross-language perception studies, English voiceless stops are systematically mapped to aspirated stops and English voiced stops vary between lenis and fortis stops of Korean (Park and deJong 2008 among others). Given this equivalence pattern, if English influence on Heritage Korean is primarily in the assimilation of VOT values in equivalent sounds, we would expect the shortening of VOT in both aspirated and lenis stops toward the values of English voiceless and voiced stops, respectively. On the other hand, English speakers perceive both Korean long lag stops predominantly as equivalent to voiceless

stops of English (Schmidt 2008). Under this latter equivalence, we expect VOT of lenis and aspirated stops to merge toward that of English voiceless stops. In both cases, we predict the VOT of aspirated stops to shorten. However, the change in progress in the homeland variety complicates the interpretation of any VOT drift toward a more-English like duration in Heritage Korean as being due (solely) to contact with English.²

Another way to examine the potential influence of English in Heritage Korean is to examine the weighting of VOT and F0 cues in realizing stop contrasts. While English also exhibits consonant-induced F0 perturbation, i.e., F0 of the following vowel is higher for voiceless than voiced stops (Haggard et al. 1969, Hombert 1978, Kingston and Diehl 1994, among others), the role of F0 in voicing contrast is far more limited than in Korean and VOT is the primary cue for the contrast (Abramson and Lisker 1985, Haggard et al. 1969, Jun 1996). Under this view, we expect that the tonogenesis-like sound change in Seoul Korean will find resistance in Heritage Korean due to influence from English, which uses VOT as a primary cue for stop contrast. In other words, we expect VOT to play a more significant role in stop contrast in Heritage Korean than in Seoul Korean. With this background, we turn to our study of Heritage Korean.

4. Methods

Our study is situated in Toronto, a city with a community of approximately 55,000 people who defined themselves as ethnically Korean in the 2006 census (Statistics Canada 2009) and about 49,000 people claiming Korean as their mother tongue (Statistics Canada 2007). There has been a community of Korean speakers in Toronto since ~1967 (Nagy 2011:66). The data come from the Heritage Language Documentation Corpus (Nagy 2009, 2011), consisting of sociolinguistic interviews with Toronto speakers in several generations of six heritage languages, stratified by age and sex. All Korean speakers in the corpus (or their parents) come from Seoul, South Korea and were recorded 2009-2011. Speakers were recruited from the personal networks of research team members who are Toronto heritage language speakers. Participants self-identify as “fluent enough to participate in an hour-long conversation in the heritage language.” The interviews were conducted in the heritage language and produced about an hour of conversational speech from each participant, covering topics ranging from speaker’s upbringing and interests to their attitudes toward ethnic communities in Toronto. This approach allows us to describe naturalistic speech and requires us to carefully examine (or control) contextual effects.

Heritage speakers are categorized by generation. Generation 1 is defined to include people born in Seoul, who lived there until at least age 18, and subsequently have lived in Toronto for at least 20 years. Generation 2 speakers are born in Toronto, or came from Seoul before age 7, for whom both parents qualify as Generation 1. Table 1 describes the 22 speakers that we examine.

² It is also possible that the change in Seoul Korean itself is due to contact with English.

Table 1: Speaker distribution

	Female	Male
Generation 1	5	5
Year of Birth	1926-1967	1939-1964
Age of Arrival	25-56	22-48
Year of Arrival	1972-1992	1973-1990
Generation 2	7	5
Year of Birth	1967-1992	1975-1988
Age of Arrival	0-7	0-7
Year of Arrival	born in GTA or 1974-1997	born in GTA or 1977-1989

In contrast to most published studies of VOT in bilingual contexts that are based on experimental elicitations (read words or sentences), we investigate VOT in conversational speech. Speakers participated in three digitally-recorded tasks. First is a sociolinguistic interview (methodology in Labov 1984, questionnaire available at http://projects.chass.utoronto.ca/ngn/pdf/HLVC/long_questionnaire_English.pdf), a relaxed conversation in the heritage language. The goal of this task is to collect naturalistic in-group conversational speech, the basis of the present analysis. All interviews are conducted by heritage language speakers whose background is from the same region of origin as the participant (here, Seoul). An ethnic orientation questionnaire and a picture description task are also conducted, but these are not relevant to this study.

The interviews were transcribed in Korean orthography (*Hangul*) in ELAN (Wittenburg *et al.* 2006) by native Korean speakers. This creates time-stamped transcriptions which are linked to the .wav file of the interview recording. Tokens of word-initial stops were then manually located in the transcribed speech of 22 individuals representing two generations of speakers (10 Generation 1 and 12 Generation 2). For maximal comparability to the NIKL data, we restrict our examination to Accentual Phrase-initial words beginning with one of the nine Korean stops. Accentual Phrases (AP) in Korean are defined as beginning with a LH (for words beginning with a lenis stop or a sonorant) or HH (for words beginning with fortis or aspirated stops, /h/ or coronal fricatives) initial boundary tone and ending with a LH final boundary tone (Jun 1993, 1996). Only tokens that were clearly audible and free of speech errors and background noise were selected. A total of 3,222 AP-initial tokens were analyzed: 380 aspirated, 2,496 lenis and 346 fortis stops.

For each target word, the onset of the stop release, the onset of voicing of the following vowel and the offset of the vowel were manually identified. Acoustic measurements of VOT and F0 at the vowel midpoint were made in *Praat* (Boersma and Weenink 2011). VOT was defined as the duration from the onset of the stop release to the zero crossing at the upward swing of the first periodic cycle of the following vowel. Fig. 4 illustrates the phonetic realization of VOT for one token of lenis stop /t/. The highlighted segment is the time period between the release of the coronal constriction and the onset of periodic voicing of the following /ə/. F0 measurements were taken at the midpoint of vowels using *Praat's* pitch tracking function with pitch range set at 75-300 Hz for male speech and at 100-500 Hz for female speech. Acoustic measurements were taken using the script function in *Praat*. For statistical analyses, F0 measurements in Hz are converted to semitones (St), a logarithmic scale of pitch, to allow for comparison of pitch range across sex and age (Whalen and

Levitt 1995, Oh 2011). St was calculated with 100Hz as a reference pitch using the formula, $\log(\text{Hz}/100)*12$.

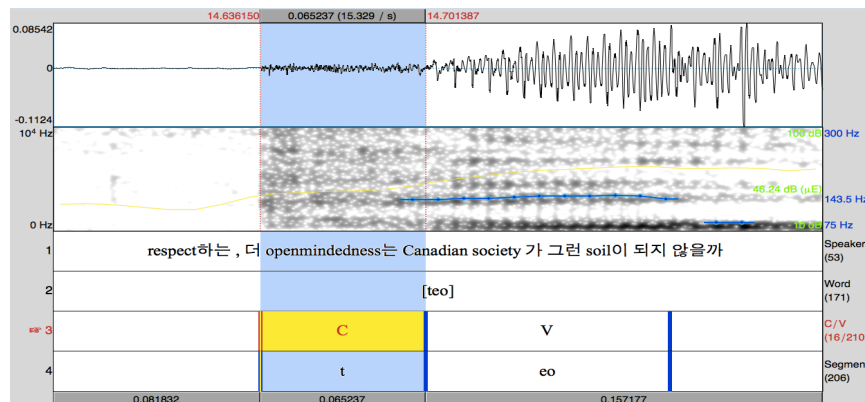


Figure 4: VOT intervals labeled in Praat for a token of /t/ produced by Speaker KIM45A, a 45-year old Generation 1 male (65 msec. release highlighted)

Statistical analyses are based on mixed-effects logistic regression modeling (Pinheiro and Bates 2000; Baayen, Davidson, and Bates 2008) using the *lmer* function in the *lme4* package (Bates, Maechler, and Bolker 2011) for R (R Development Core Team 2011). The dependent variable is the laryngeal category: aspirated or lenis. The independent variables, or fixed effects, are VOT and F0. Interactions of generation (G1, G2) with VOT and F0 are also examined. Speaker is included as a random effect. This produces a model showing how well we can predict the phonemic status (lenis or aspirated) of a given token from VOT and F0, and how the effect of VOT and F0 vary by generation. Separate models were built for each sex.

Before we turn to the results, it is important to note a methodological limitation of the study: while the Heritage data is from conversational speech, the homeland comparison data is from read speech. Therefore, rather than directly comparing the raw acoustic measurements from the two data sets, we focus on how the weighting of acoustic cues interacts with sociolinguistic variables (sex and generation/age³) in each community.

5. Results

We first show the mean VOT and F0 values for each consonant series by speakers' generation and sex in Heritage Korean in Fig. 5. For male speakers, we find that the VOT contrast between aspirated and lenis stops decreased significantly from Generation 1 to Generation 2. The F0 contrast between the two stops increased significantly from Generation 1 to Generation 2. This is similar to the pattern found in Seoul Korean (cf. Fig. 1). For female speakers, on the other hand, the two generations show almost identical patterns in that the

³ Because "generation," as defined with respect to immigration for the HLVC project, is not an applicable concept in the homeland context, generational contrasts in the heritage data are considered alongside age contrasts in the homeland data.

VOT and F0 contrasts between the aspirated and lenis stop series are similar in the two generations.⁴

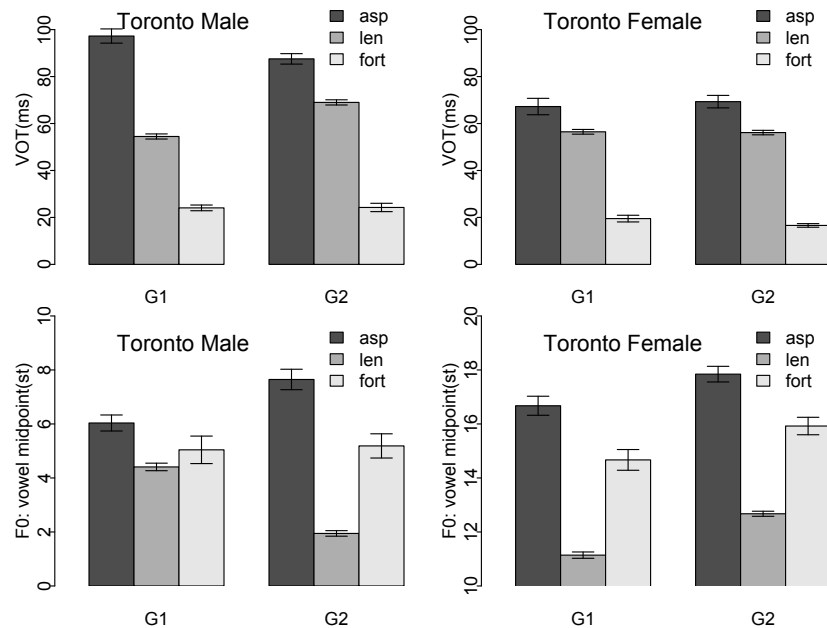


Figure 5: Mean VOT (top row) and mean F0 (bottom row) values for the three series of stops in Heritage Toronto by speakers' sex and generation.

Fig. 6 shows the distribution of the aspirated and lenis stops from the same data plotted in two dimensional acoustic space of VOT by F0. A mixed-effects logistic regression model for the male speakers indicates significant main effect for both VOT and F0. There is an interaction with generation for both of these: younger males use F0 more and VOT less as a cue to the phonemic contrast between aspirated and lenis stops. This is illustrated in Fig. 6 by the steeper slope of the line dividing the aspirated and lenis clouds in the Generation 1 graph than the Generation 2 graph – the primary cue is VOT in Generation 1 but F0 in Generation 2. In other words, for male speakers, similar to Seoul Korean, there is a clear generational shift in the cue weighting.

Female speakers, in contrast, show different cue weighting pattern and generational effect than female speakers of Seoul Korean. First of all, unlike Seoul Korean female data, where VOT was not a significant predictor of aspirated-lenis distinction, both VOT and F0 were significant predictors in the speech of Heritage Korean female speakers. Second, while in Seoul Korean F0 played a more substantial role in younger than in older female speakers, no such interaction of F0 and generation was found in the Heritage female data. In other words, the younger female speakers of Heritage Korean do not push the change further but remain practically identical to older generation of female speakers.

⁴ Differing mean VOT values between generations, or between men and women, may be an epiphenomenon of different speech rates. To rule this out, we examined normalized VOT: VOT divided by the duration of the following vowel. The overall pattern persists.

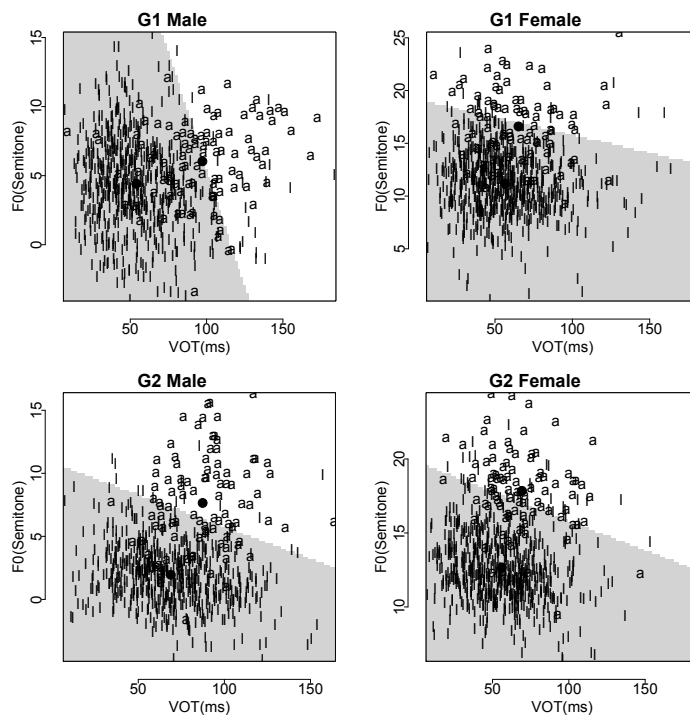


Figure 6: Trading relation between F_0 and VOT for distinguishing aspirated (a) vs. lenis (l) stops by speakers' sex and generation in Heritage Korean.

The difference between the Seoul and Toronto female Korean data becomes even more evident when we examine the difference in mean VOT values between aspirated and lenis stops of individual speakers. In Fig. 7, positive values along the y-axis indicate that the speakers produce the aspirated stops with longer VOT values than the lenis stops, while negative values indicate that lenis stops have longer VOT than aspirates. For the vast majority of male speakers, the values are positive but there is a clear downward trend for both Homeland and Heritage speakers from older to younger males, indicating that in both varieties, the VOT difference between the two stop categories is decreasing. The slopes of the trend lines for the two groups are similar.⁵

For female speakers, however, Seoul and Toronto patterns are quite different. In the Seoul data, there is a clear downward trend (indicated by the dotted line). Additionally, the VOT merger is further advanced than for Seoul

⁵ It is notable that Homeland speakers have shorter VOT compared to their age peers in the Heritage sample, except for Generation 1 females. This difference may be attributed to the influence of English, where VOT is a primary cue for stop voicing contrasts. The exceptional patterning of Generation 1 females, most of whom are housewives, may be due to their relatively limited use of English. But, as noted in §4, due to the difference in the speech styles of the two data sources, we should be cautious about comparing their raw values.

males: many speakers exhibit a negative value for the aspirated-lenis difference, indicating that they produce aspirates with *shorter* mean VOT values than lenis stops. For Toronto speakers (indicated by the nearly horizontal solid trend line) on the other hand, we observe a U-shaped pattern where the youngest female speakers seem to reverse the trend and produce a VOT difference between the two stop categories that is similar to that of the oldest Generation 1 speaker. In contrast, the mid-range (by age) speakers have ratio values closer to 0. Determining whether this is a flat or a U-shaped pattern requires analysis of additional speakers, but the contrast to the male pattern is already clear.

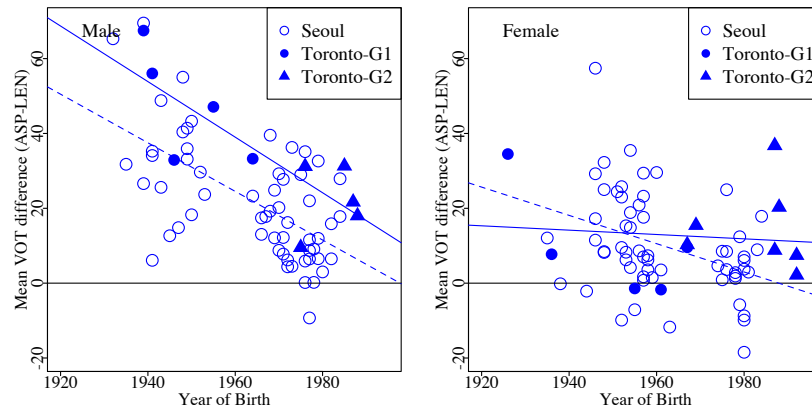


Figure 7: Mean VOT difference between aspirated and lenis stops by speakers' Year of Birth in the Homeland (Seoul) and two Heritage generations.

To summarize, the shift in cue weighting from VOT to F0 from older to younger speakers observed in Seoul Korean is also clearly observable in male Heritage Korean speech. In the female Heritage data, on the other hand, the younger generation does not push the change further ahead and possibly is even reversing the direction of change. When we compare the values of the aspirated/lenis difference we see that the Heritage females gather toward the lower end of the males' range: as a group, they are ahead of the males in favouring F0 over VOT as a cue to the aspirated/lenis contrast. This is most easily seen by noting that the Heritage females' horizontal trend line is at approximately the same value as the right end of the males' trend line. In contrast, the endpoints for the Homeland speakers of both sexes have reached a similar value (near 0), although the females started at a higher value during the same time period.

6. Discussion: Three possible accounts of the Heritage Korean pattern

The general picture that emerges from the data is that the tonogenetic process in progress in Seoul is continued in Toronto. Overall, the Heritage speakers' production of aspirated and lenis stops resembles Homeland Korean speakers', in terms of the trade-off between VOT and F0 across generations and the differences between men and women, although Toronto males maintain a larger contrast in VOT than their Seoul counterpart (see fn. 5). When we compare the Homeland (Fig. 2) and Heritage (Fig. 6) findings, we see that the males in

Toronto appear to be doing very much the same as the males in Seoul: in both communities, the role of VOT decreases in younger vs. older males but VOT continues to play a role in distinguishing aspirated stops from lenis stops. Generation 1 females in Toronto also resemble the Homeland speakers. However, the Generation 2 (younger) females do not seem to have progressed beyond the Generation 1 (older) speakers, but rather replicate the same pattern or possibly even reverse the direction of change. Why do the younger female speakers, and only they, diverge from the pattern observed in the Homeland?

Recall that VOT, alongside F₀, is a significant predictor of the lenis-aspiration distinction in the Heritage Korean model for females, while only F₀ was significant in the Homeland model. Here, we might call on English influence: the importance of VOT as the primary cue between “voiced” and “voiceless” stops in English, the dominant language of many Generation 2 speakers, may influence their Korean, preventing them from entirely giving up VOT as a cue for stop contrast. The fact that the two generations of females in Toronto differ little in their behaviour may be seen as evidence that the females in Generation 1 had already approached an endpoint in the change—moving farther along the trajectory found in Seoul would require giving up (or even reversing) a cue to a phonemic contrast that is important in English, the dominant language of many of them. In contrast, English is not the dominant language in Seoul, so it doesn’t act as a roadblock to this change in progress there. Toronto men are slightly behind women and have not yet reached the point where continuing to diminish the VOT contrast would be problematic. Under this interpretation, the sex contrast in the younger Heritage speakers—females do not progress further along the Seoul-like change while males continue to do so—is a by-product of the fact that the females are further along in the trajectory of change than the males.

A second possibility is that that the Generation 2 heritage speakers (the first generation of speakers that acquired the language outside the homeland context) are simply not acquiring the sex-conditioned variation (Gerard van Herk, p.c., May 2012). (Returning to Fig. 5, we can see that the absolute differences between the average values for males and females are less for Generation 2 than Generation 1, for both cues.) Heritage varieties may not exactly mimic Homeland varieties because the input received by the speakers is deficient, if only quantitatively, because some of the input that learners in a Heritage context receive is in the dominant language (Polinsky 2008). It is also plausible that in contact situations, some social factors, relating to language attitudes and degree of contact, may be more important than sex, a factor that is regularly shown to be significant in variation in monolingual contexts. In a case of deficient input, we would expect diminishing effect sizes as well as a change in the conditioning effects on the variable, much as proposed in Labov (2007) for the diffusion of a phonological variable when multiple dialects are in contact. While further analysis might show this to be the case, we do not have sufficiently comparable data sets at this point to test this hypothesis. We leave this question for future studies.

A third possibility is that the behavior of younger female Heritage speakers indicates the onset of a female-led change in the reverse direction, i.e., female speakers are actively (re)introducing the VOT contrast due to the influence of English. This follows the sociolinguistic expectation that in female-led changes, males more fully retain the speech pattern they inherit from their

caregivers and their speech remains more stable through adolescence while females push the change ahead further during the teenage years (Labov 2001). This behaviour on the part of the females resembles that observed in at least one other situation. Kera, a Chadic language spoken in Chad and Cameroon, is a language that has recently undergone a tonogenesis-like change. The “voicing” contrast is now signaled primarily by F0 and secondarily by VOT. Speakers who live in towns are in contact with French (a contrastive VOT language) and they show increased sensitivity to VOT, in contrast to monolingual speakers living in villages. In both towns and villages, females lead: they are more Kera-like in the villages and more French-like in the towns (Pearce 2009). The pattern has made a U-turn in towns—the VOT contrast that was on its way out in the monolingual (villager) speech is reintroduced due to the influence of French, a more prestigious language with which Kera is in contact.

The first two of the three views discussed above predicts that the gender contrast will be largely neutralized in later generations. The second additionally predicts concomitant change in other conditioning factor effects. The third predicts that females will be a step ahead in reintroducing the VOT contrast, but that males will follow. To determine which explanation best accounts for the data, we must wait and see what trajectories emerge in the future.

References

- Abramson, Arthur, and Lee Lisker. 1985. Relative power of cues: F0 shift versus voice timing. In *Phonetic Linguistics*, ed. V. Fromkin, New York: Academic.
- Antoniou, Mark, Catherine T. Best, and Michael D. Tyler, and Christian Kroos. 2010. Language context elicits native-like stop voicing in early bilinguals’ productions in both L1 and L2. *Journal of Phonetics* 38:640–653.
- Baayen, R. Harald, Douglas J. Davidson, and Douglas M. Bates. 2008. Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language* 59:390–412.
- Bates, Douglas, Martin Maechler, and Ben Bolker. 2011. lme4 package.
- Boersma, Paul, and Weenink, David 2011. Praat: doing phonetics by computer [Computer program]. Version 5.2.25. <<http://www.praat.org/>>
- Chang, Charles B. 2012. Rapid and multifaceted effects of second-language learning on first- language speech production. *Journal of Phonetics* 40:249-268.
- Cho, Taehong, Sun-ah Jun, and Peter, Ladefoged. 2002. Acoustic and aerodynamic correlates of Korean stops and fricatives. *Journal of Phonetics* 30:193–228.
- Choi, Hansook. 2002. Acoustic cues for the Korean stop contrast: dialectal variation. *ZAS papers in linguistics* 28:1–12.
- Flege, James E. 1987. The production of “new” and “similar” phones in a foreign language: Evidence for the effect of equivalence classification. *Journal of Phonetics* 15:47–65.
- Flege, James E., and Wieke Eefting. 1987. Production and perception of English stops by native Spanish speakers. *Journal of Phonetics* 15:67–83.
- Fowler, Carole, Valery Sramko, David J. Ostry, Sarah A. Rowland, and Pierre Hallé. 2008. Cross language phonetic influences on the speech of French–English bilinguals. *Journal of Phonetics* 36:649-663.
- Haggard, Mark, Stephen Ambler, and Mo Callow. 1969. Pitch as a voicing cue. *Journal of the Acoustical Society of America* 47:613–617.
- Han, Meiko, S., and Raymond S. Weitzman. 1970. Acoustic features of Korean /P, T, K/,

- /p, t, k/ and /ph, th, kh/. *Phonetica* 22:112-128.
- Hardcastle, William J. 1973. Some observations on the tense-lax distinction in initial stops in Korean. *Journal of Phonetics* 1:263–272.
- Hombert, Jean-Marie, John J. Ohala, and William G. Ewan. 1979. Phonetic explanations for the development of tones. *Language* 55:37-58.
- Hrycyna, Melania, Natalia Lapinskaya, Alexei Kochetov, and Naomi Nagy. 2011. VOT drift in 3 generations of Heritage Language speakers in Toronto. *Canadian Acoustics* 39.3:166-167.
- Jin, Wenhua. 2008. *Sounds of Chinese Korean: a Variationist Approach*. Ph.D. Thesis, Arlington, Texas: University of Texas at Arlington.
- Jun, Sun-Ah. 1993. *The phonetics and phonology of Korean prosody*. Ph.D. Thesis, Columbus, Ohio: The Ohio State University.
- Jun, Sun-Ah. 1996. Influence of microprosody on macroprosody: a case of phrase initial strengthening. *UCLA Working Papers in Phonetics* 92:97-116.
- Kang, Kyoung-Ho, and Susan G. Guion. 2008. Clear speech production of Korean stops: Changing phonetic targets and enhancement strategies. *Journal of the Acoustical Society of America* 124:3909–3917.
- Kang, Kyoung-Ho, and Susan G. Guion. 2006. Phonological systems in bilinguals: Age of learning effects on the stop consonant systems of Korean–English bilinguals. *Journal of the Acoustical Society of America* 119:1672–1683.
- Kang, Yoonjung. Submitted. Tonogenesis in Seoul Korean: a corpus study.
- Kang, Yoonjung, and Sungwoo Han. Submitted. Tonogenesis in early Contemporary Seoul Korean: a longitudinal case study.
- Kim, Chin-Wu. 1965. On the autonomy of the tensity feature in stop classification (with special reference to Korean stops). *Word* 21:339-359.
- Kim, Mi-Ran Cho. 1994. *Acoustic characteristics of Korean stops and perception of English stop consonants*. Ph.D. Thesis, University of Wisconsin-Madison.
- Kim, Midam. 2004. Correlation between VOT and F0 in the perception of Korean stops and affricates. In: *Proceedings of the 8th international conference on spoken language processing (INTERSPEECH-2004)* (pp. 49–52). Jeju Island, Korea: International Speech Communication Association.
- Kim, Mi-Ryung, Patric S. Beddor, and Julie Horrocks. 2002. The contribution of consonantal and vocalic information to the perception of Korean initial stops. *Journal of Phonetics* 30:77-100.
- Kingston, John, and Randy L. Diehl. 1994. Phonetic knowledge. *Language* 70:419–494.
- Kingston, John. 2011. Tonogenesis. In *The Blackwell Companion to Phonology*: eds. Mark van Oostendorp, C. J. Ewen, Elizabeth Hume, and Keren Rice. Blackwell: Blackwell Reference Online. http://www.companiontophonology.com/subscriber/tocnode?id=g9781405184236_chunk_g978140518423699.
- Kong, Eun Jong, Mary Beckman, and Jan Edwards. 2011. Why are Korean tense stops acquired so early?: The role of acoustic properties. *Journal of Phonetics* 39:196–211.
- Labov, William. 1984. Field methods of the Project on Linguistic Change and Variation, In *Language in Use*, eds. John Baugh and Joel Sherzer, 28-53. Englewood Cliffs, NJ: Prentice Hall.
- Labov, William. 2001. *Principles of linguistic change, vol. iii: Social factors*. Malden and Oxford: Blackwell.
- Labov, William. 2007. Transmission and diffusion. *Language* 83:344–87.
- Lisker, Lee, and Arthur Abramson. 1964. A cross-language study of voicing in initial stop: acoustic measurements. *Word* 20:384-422.
- Nagy, Naomi. 2009. Heritage Language Variation and Change in Toronto. <http://projects.chass.utoronto.ca/ngn/HLVC>.

- Nagy, Naomi. 2011. A Multilingual corpus to explore variation in language contact situations. *Rassegna Italiana di Linguistica Applicata* 43.1-2:65-84.
- NIKL (The National Institute of the Korean Language). 2005. *A Speech Corpus of Reading-Style Standard Korean*.
- Oh, Eunjin. 2011. Effects of speaker gender on voice onset time in Korean stops. *Journal of Phonetics* 39:59-67.
- Park, Hanyong and Kenneth J. de Jong. 2008. Perceptual category mapping between English and Korean prevocalic obstruents: Evidence from mapping effects in second language identification skills. *Journal of Phonetics* 36:704-723.
- Pearce, Mary. 2009. Kera tone and voicing interaction. *Lingua* 119:846-864.
- Pinheiro, José C., and Douglas M. Bates. 2000. *Mixed-effects models in S and S-PLUS*. New York: Springer.
- Polinsky, Maria. 2008. Gender under incomplete acquisition: Heritage speakers' knowledge of noun categorization. *Heritage Language Journal* 6.1:40-71.
- R Development Core Team. 2011. *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. <http://www.r-project.org>.
- Ringen, Catherine, and Kulikov, Vladimir. 2010. Voice Onset in Russian. 16th Annual Mid-Continental Workshop on Phonology (MCWOP). Chicago, IL. myweb.uiowa.edu/vkulikov/MCWOP16_handout.pdf.
- Ringen, Catherine, and Kulikov, Vladimir. to appear. Voicing in Russian Stops: Cross-linguistic implications. *Journal of Slavic Linguistics* 20.2.
- Roever, Christian, Nils Raabe, Karsten Luebke, Uwe Ligges, Gero Szepannek, and Marc Zentgraf. 2011. KLaR package.
- Sancier, Michelle, and Carole A. Fowler. 1997. Gestural drift in a bilingual speaker of Brazilian Portuguese and English. *Journal of Phonetics* 25:421-436.
- Schmidt, Anna Maria. 2007. Cross-language consonant identification: English and Korean. In *Language experience in second language speech learning: In honor of James Emil Flege*, eds. Ocke-Schwen Bohn and Murray J. Munro, 185-200. Amsterdam: John Benjamins.
- Silva, David. 2006. Acoustic evidence for the emergence of tonal contrast in contemporary Korean. *Phonology* 23:287-308.
- Sorianello, Patrizia. 1996. Indici fonetici delle occlusive sorde nel cosentino. *Rivista Italiana di Dialettologia* 123-159.
- Statistics Canada. 2009. Immigrant population by place of birth and period of immigration (2006 Census). <http://www40.statcan.ca/101/cst01/demo24a-eng.htm>.
- Statistics Canada. 2007. Population by mother tongue, by census metropolitan area (2006 Census). <http://www40.statcan.ca/101/cst01/demo12c-eng.htm>.
- Thurgood, Graham. 2002. Vietnamese and tonogenesis. *Diachronica* 19:333-363.
- Whalen, Douglas. H., and Andrea G. Levitt. 1995. The universality of intrinsic F0 of vowels. *Journal of Phonetics* 23:349-366.
- Wittenburg, Peter, H. Brugman, Albert Russel, A. Klassmann, and Han Sloetjes. 2006. ELAN: a Professional Framework for Multimodality Research. *Proceedings of LREC 2006, Fifth International Conference on Language Resources and Evaluation*.
- Wright, Jonathan. D. 2007. *Laryngeal Contrast in Seoul Korean*. Ph.D. Thesis, Philadelphia, Pennsylvania: University of Pennsylvania.