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VOT merger and f0 contrast in Heritage Korean in California

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Abstract
Recordings of read speech in Korean and English were made by native South Koreans and Korean Americans of varying generational status ("second-generation" American-born or "1.5-generation" foreign-born) and analyzed for differences in usage of VOT and fundamental frequency to contrast production of Korean lenis and aspirated stops and affricates. Results show that second-generation Korean speakers, especially females, are not showing the collapse of VOT contrast found in the other two groups, which is part of a sound change nearing completion in Seoul. Female second-generation speakers are also not using f0 to differentiate between the stops to the extent that first- and 1.5-generation speakers are. It is concluded that second generation Korean Americans are not participating in the sound change that their same-age peers in Seoul are, and that second generation and 1.5 generation Korean Americans do not pattern together phonologically as a "heritage speaker" category. The analysis makes a stronger case for applying new models of language acquisition, speech production, and identity formation to heritage language speakers that differ from those used for bilingual speakers.

VOT merger and f0 contrast in Heritage Korean in California

Andrew Cheng*

1 Background

1.1 Sound Change in Korean

Korean possesses a typologically unique three-way contrast in manner of articulation that has been described as "laryngeal" or a "phonation contrast" (Cho et al. 2002, Kim-Renaud 2014). The phonemic stops and affricates that demonstrate this contrast are most commonly called lenis, fortis, and aspirated and occur at bilabial, alveolar, and velar places of articulation as stops, and post-alveolar as affricates. Though phonetic descriptions of each type of consonant are variable in the present literature, it is generally agreed upon that differentiation across acoustic properties lies primarily in voice quality, VOT, and fundamental frequency (f0) of the subsequent vowel (Cho et al. 2002, Han and Weitzman 1970). The current study focuses on VOT and f0 and draws from the evidence for a sound change in progress that affects how these properties are used in production of lenis and aspirated stops and affricates by certain populations of Korean speakers.

When lenis stops and affricates occur utterance-initially or word-initially, they undergo VOT lengthening, resulting in phonetic aspiration (Silva 2002, 2006b). This makes word-initial lenis stops more similar to aspirated stops, although a phonemic contrast is still maintained. In the past, this has taken the form of a three-way VOT contrast (fortis with the lowest VOT, aspirated with the highest VOT, and lenis in between).[1]

However, recent studies of the variety of Korean spoken in the capital city, Seoul, and its surrounding region, Gyeonggi-do, have shown that the phonetic difference between lenis and aspirated stops along the dimension of VOT is collapsing in certain prosodic contexts. For lenis and aspirated stops that occur at the beginning of an accentual phrase (AP), speakers are now increasing usage of f0 of the subsequent vowel to distinguish the two, with aspirated stops and affricates having a higher pitch than lenis (Silva 2006a, b, Kang and Guion 2008). This pitch difference has been accounted for in the earliest studies of Korean, but according to Silva (2006a), it was intrinsic and even considered 'redundant', as it was not used as the primary contrast marker.

With the apparent diminishing of the VOT dimension of distinction between aspirated and lenis, then, pitch is rising to take its place; the parallel changes in VOT and f0 are presumed to have happened closely or "in tandem" (Bang et al. 2015). Importantly, this change is limited to the AP-initial context and disappears in other prosodic contexts, such as in the middle of an utterance or at the end of a word, in which many of the phonemes in question undergo neutralization to an unreleased homorganic lenis stop. It may also be affected by lexical frequency and following vowel height (Bang et al. 2018). This change has been shown in production as well as perception (Kim and Beddor 2002, Kim 2004). From a sociolinguistic perspective, in addition to age and generational differences (where younger speakers are advancing the change), female speakers lead over male speakers (Oh 2011), Seoul and northern metropolitan speakers lead over southern (regional dialect) speakers (Choi 2002), and, potentially, speakers with L2 proficiency in English lead over those without (Kim 2013). The emergence of pitch as the primary means of contrast may have begun as recently as two generations ago (Kang and Han 2013); the contrast is found and categorical in most younger speakers of Seoul Korean, therefore signaling sound change near completion. All speakers born later than 1960 in the corpus study of Kang (2014) show the change in AP-initial f0 distinction,

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[1]Most romanization systems for Korean use '*b,d,g*' for the lenis stops and '*p,t,k*' for the aspirated stops, as I do here. However, at least word-initially, all of these stops are voiceless. Romanization is indicated by italics and will be used in place of IPA henceforth.

though only females born earlier (as early as 1940) showed the change, possibly indicating that they were the vanguard.

The timing was approximately the same for the change in VOT distinction; all speakers born from 1960 to 1980[2] show a smaller aspirated-lenis VOT difference, with females again leading in the directionality of change. However, interspeaker variation still exists; it is considered a change in progress (Bang et al. 2015). Some studies refer to this phenomenon as tonogenesis, or a tonogenetic sound change, but it is clear that Korean has not developed phonological or lexical tone in the manner of prototypical tone languages, so I will continue to refer to this as a "VOT merger and f0 contrast" sound change.

Most of this research has been limited to native speakers of Korean who reside in the regions where the sound change is understood to have originated. In one recent study, however, the speech of diasporic Koreans was tested for the presence of pitch contrast between lenis and aspirated stops and affricates. Kang and Nagy (2016) extracted VOT and f0 data from conversational speech in a corpus and analyzed the measurements in relation to demographic factors such as generational cohort ("first-generation" or "second generation") and gender. They found that Koreans born and raised in Toronto differentiated lenis and aspirated stops and affricates in production with a VOT merger and pitch contrast that resembled "homeland Korean" speakers, but not to the extent of an exact replication. The second generation Korean Canadians are of particular interest, because their ethnicity and common language link them to peninsular South Koreans, yet the unique circumstances of their Korean input, language environment, and multicultural identity could be the basis for an interesting twist on the "transition problem" (Weinreich et al. 1968): namely, these factors may collude to inhibit the generational transmission of the sound change in question.

1.2 Heritage Korean

Korean migration to the United States has occurred in three waves. The first wave occurred in the early 1900s in the form of migrant laborers who settled mostly in Hawaii. After the Korean War, in the 1950s and 1960s, many immigrants to the continental US were refugees. However, the passage of the US Immigration Act of 1965 opened the doors to mass immigration from East Asia. This sharp increase in Korean immigrants led to the development of vibrant Korean ethnic enclaves, such as Koreatown in Los Angeles.

After first generation Korean immigrants settled down, their children who were born in the US, whom we call second generation Korean Americans, tended to grow up with multiple languages. Generally, second generation Korean Americans hear Korean spoken at home, and sometimes in their neighborhood, but learn English at school. However, as a group, the second generation has had difficulty maintaining proficiency in Korean as they grow older, despite the efforts of the wider community to develop classes and programs for language retention (Kim 2001a, Au and Oh 2009). In addition to the first and second generational categories, there is a third category, which the Korean community calls "1.5 generation". This generally refers to child and adolescent immigrants who lived long enough in Korea to go to school and be immersed in the language and culture, before moving to the US with their families. 1.5 generation Korean Americans develop full (if not adult-like) Korean proficiency prior to relocation to a majority-English environment, and may experience some attrition in Korean after some time in the US.

A combination of 1.5 and 2nd generation Korean Americans may be considered to be "heritage speakers". This term has been defined in many ways (in particular with respect to "native speaker"), but it most often refers to speakers with an ethno-cultural affiliation to a language (He 2006) and varying degrees of proficiency (Polinsky and Kagan 2007), though they are usually more competent in the L2 than the heritage language (HL). Recent research indicates that heritage speakers' HL competence is affected by contact with the dominant language/L2 (English) and orientation toward the dominant culture. However, not all heritage speakers be modeled in the same way; we must take into account interspeaker variability, stemming from differences in the quality of HL input to the child (Flege 2007, Domínguez 2009) and the child's own active use of the language, versus passive

[2]No speakers in the National Institute of the Korean Language corpus were born after 1984.

"overhearing" (Au et al. 2002, Chang et al. 2011). Some studies have argued that heritage speakers as a group are more successful at maintaining both language-internal and cross-linguistic phonetic contrast, due specifically to early exposure to the language(s) that adult learners would not have (Jia et al. 2006, Chang 2016). For Korean specifically, Lee et al. (2006) showed that childhood speakers were as good as native speakers in perception and production of the tense-lax-aspirated contrast, and childhood hearers outperformed novice Korean learners in perception but not production. For Korean-English sequential bilinguals, the age of acquisition of English influences the VOT of stops produced in both languages; early sequential bilinguals appeared to have two separate systems for Korean stops and English stops, while late bilinguals demonstrated a merged system (Kang and Guion 2006).[3]

This paper addresses two sociolinguistic questions about the bilingual Korean American population. First, do second generation Korean Americans bilingual in Korean and English match up with their same-age peers from Seoul with respect to the Korean VOT merger and f0 contrast? Or do they not show evidence of the sound change in progress, and if so, why not? While Kang and Nagy (2016) gives precedent for second generation Koreans to mostly adopt the sound changes from Seoul, the current study looks at Korean Californians who belong to a younger cohort. The age difference is important here, because if Kang and Nagy were correct in predicting a reversal in the sound change in the younger generation, then this should be borne out in the Korean Californian heritage speakers. The prediction is that while recent young immigrants from South Korea will exhibit the VOT merger and f0 contrast, young Korean Californians will not exhibit as much of it, perhaps even less than the (older) Korean Canadians did.

Second, does "heritage speaker" constitute a meaningful sociolinguistic category for this subpopulation of Korean speakers that reflects patterns of phonological acquisition? If "heritage speaker" means 1.5 and 2nd generation Korean Americans, is this reflected in their participation in the sound change? However the Korean Californians behave, their participation (or lack thereof) will raise additional questions, such as how their identity as "second gen", "1.5 gen", or "children of immigrants" may be indicated or marked by the sociophonetic variables of VOT merger and f0 contrast. This variable is certainly not yet a linguistic stereotype, but it may already index "Korean-ness" to a certain group or sub-group of Koreans.

2 Methods

This experiment compares native Korean speakers with heritage speakers, with generational status used as a stand-in for heritage speaker identity. Koreans who had immigrated to California from Seoul at age 15 or later were categorized as first-generation (G1, n=13), and those born in America or who had moved permanently before the age of 2 were categorized as second generation (G2, n=18).[4] A number of subjects were born and raised in South Korea but immigrated to the United States between the ages of 2 and 14, or had moved back and forth between the United States and South Korea (and sometimes other countries). These were included in the 1.5-generation category[5] (G1.5, n=14). G1.5 and G2 comprise our heritage speakers.

Forty-five native and heritage Korean speakers (30 female, average age 21.18) were recruited

[3]Note that the speakers in this study were not categorized as heritage speakers, though some of the "early sequential bilinguals" may have been, according to the working definition.

[4]Though the literature is not consistent with respect to the question of exactly when an infant's L1 phonology is concretized enough to influence an L2, it has been shown that by two years of age, bilingual children establish separate (though nonautonomous) phonological systems for their languages (Paradis 2001); also see Lleó and Kehoe (2002).

[5]Admittedly, using age of immigration as a way to categorize speakers is a half-way compromise between using age of English acquisition and asking speakers outright how they self-identify, but it is a common quick diagnostic that Korean Americans themselves use to sort the young people in their community (see Park 1999, Kim and Duff 2012). And as a further note, age of immigration as a variable only correlates to date or year of immigration if all subjects, like those in this study, are of a similar age range. Subjects who immigrated at age 18 in 2015 may differ from subjects who immigrated at age 18 in 1980, depending on whether certain phonetic changes take a set amount of time to learn or can only be learned before a certain period in (historical) time.

for the production experiment and compensated monetarily for their participation. They were all either ethnic Koreans from the Seoul metropolitan area or were second generation or 1.5 generation Korean Americans who had at least one parent who was from the Seoul metropolitan area. The participants recorded Korean minimal triplets within the carrier phrase "*Naneun ___(i)rago haeyo* (I am saying/called ___)," and then in constructed sentences that used the target words in a natural context. The target words can be found in Table 1.[6] All participants also recorded a series of English words in carrier and contextualized sentences for use in a parallel study; the Korean stimuli and English stimuli were blocked in the same session. All of the speech was recorded in a sound-attenuated booth using an AKG C3000 microphone.

lenis	fortis	aspirated
bal /pal/ 'foot'	*bbal* /p͈al/ 'to suck'	*pal* /pʰal/ 'arm' or 'eight'
bat /pat/ 'field'		*pat* /pʰat/ 'red bean'
bul /pul/ 'fire'	*bbul* /p͈ul/ 'horn'	*pul* /pʰul/ 'grass'
dang /taŋ/ 'political party'	*ddang* /t͈aŋ/ 'land'	*tang* /tʰaŋ/ 'soup'
deol /tʌl/ 'less'	*ddeol* /t͈ʌl/ 'to shake'	*teol* /tʰʌl/ 'fur'
deulda /tɯl.da/ 'to enter'		*teulda* /tʰɯl.da/ 'to turn on'
jang /tɕaŋ/ 'page'	*jjang* /t͈ɕaŋ/ 'super'	*cang* /tɕʰaŋ/ 'window'
jada /tɕa.da/ 'to sleep'	*jjada* /t͈ɕa.da/ 'salty'	*cada* /tɕʰa.da/ 'to kick'
jejo /tɕɛ.dʑo/ 'manufacturing'		*cejo* /tɕʰɛ.dʑo/ 'gymnast'
jinjja /tɕin.t͈ɕa/ 'really'	*jjinbbang* /t͈ɕin.p͈aŋ/ 'bun'	*cingu* /tɕʰin.gu/ 'friend'
gan /kan/ 'liver'	*ggan* /k͈an/ 'peeled'	*kan* /kʰan/ 'train car'
geu /kɯ/ 'that'	*ggeu* /k͈ɯ/ 'to turn off'	*keu* /kʰɯ/ 'large'
gul /kul/ 'oyster'	*ggul* /k͈ul/ 'honey'	*kul* /kʰul/ 'cool'

Table 1: Minimal pairs and triplets for Korean word-initial stops and affricates, selected to provide a variety of vowel contexts and word frequencies.

Because the speakers were given a reading task, they had to have basic reading fluency in Korean. The greatest variation in reading fluency was in the G2 group of speakers, some of whom struggled with the less frequent words in the stimuli. On a three-point scale of fluency, all speakers self-rated their speaking, listening, and reading skills. All G1 speakers gave themselves threes across the board, but G2 speakers had an average self-rated speaking proficiency of 2.1 and an even lower reading proficiency of 1.7. Speakers also completed a post-task language background and attitudes survey.

Recordings (n=5900 utterances) were manually checked for quality and were then force-aligned using kp2fa (Yoon and Kang 2014), a TextGrid-alignment program that uses the HTK-Toolkit (Young et al. 2006), and then analyzed using an Inverse Filter Control formant tracker (Watanabe 2001) and an automatic VOT measuring tool (Keshet et al. 2014). TextGrids and some measurements were hand-corrected using Praat and then visualized and run through statistical tests using the relevant packages in R.

3 Results

3.1 Voice Onset Time

The results in this section are taken from measurements of the Korean target words spoken in carrier sentences. A two-way repeated measures ANOVA found a significant effect of generational group on the VOT of AP-initial aspirated stops and affricates ($F(2,615)=5.867$, $p=0.006$), as well as lenis stops and affricates ($F(2,730)=12.622$, $p<0.001$). In addition, there was an interaction effect of generation and gender for lenis VOT only ($F=6.094$, $p=0.005$). Figure 1 charts the mean VOT of

[6] Although most studies of the three-way laryngeal contrast include bilabial, alveolar, and velar stops, this study also included the post-alveolar – or alveolar (see Kim (2001b)) affricates; see (Chang 2013) for a discussion of utterance-initial Korean fricatives, which can be characterized as 'fortis' and 'non-fortis'.

each consonant type for each generational group, split by gender (though statistical tests were run on pooled data), and it is clear that the G2 females are producing AP-initial aspirated and lenis stops and affricates with a greater VOT than G1 and G1.5.

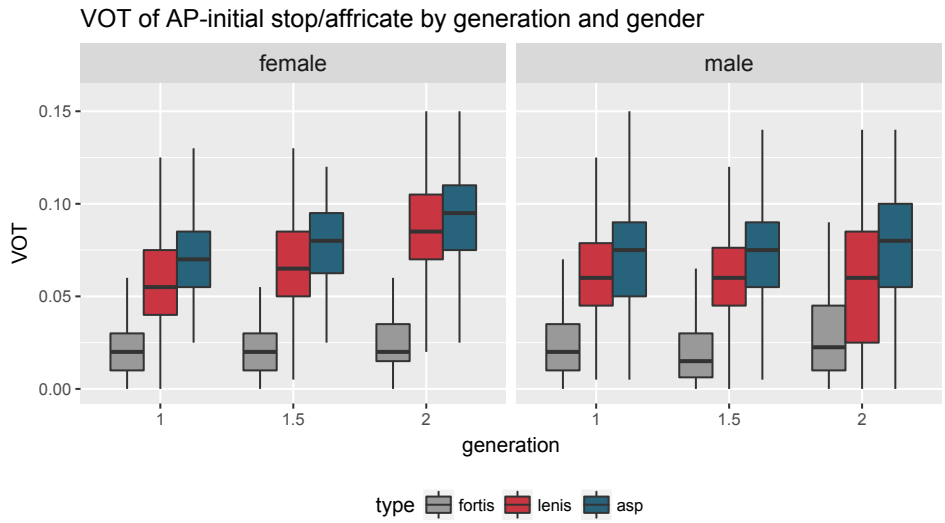

Figure 1: VOT of AP-initial stops and affricates by generation and gender.

Because the change in VOT is described as a merger, or a collapse in contrast, the mean difference in VOT between aspirated and lenis stops was calculated for each generation. If the VOT difference is zero or close to zero, this indicates a collapse in contrast. The mean VOT differences of the three groups were 0.0052 (G1), 0.0078 (G1.5), and 0.0122 (G2). The difference is objectively greater for the G2 speakers, although independent t-tests and an analysis of variance examining VOT difference among generational groups found no significant difference or significant effects of generational group or of age of immigration to the US. In sum, regardless of raw VOT values, all speakers maintained an equal amount of VOT contrast between lenis and aspirated AP-initial stops and affricates.

3.2 Fundamental Frequency

Fundamental frequency (f0) data were not normalized for gender, so female-identifying and male-identifying speakers were analyzed separately using a one-way ANOVA. Generation was not found to be significant for aspirated f0 in women ($F(2,789)=3.09$, $p=0.0632$) or men ($F(2,354)=3.405$, $p=0.0706$). Similarly, lenis f0 values were not significantly influenced by generation; see Figure 2.

However, when analyzing the f0 data in terms of the difference between an individual's aggregated aspirated and lenis consonants' f0 values, resulting in one value (mean aspirated-lenis f0) per speaker, generational group was a significant factor for females ($F(2,25)=4.501$, $p=0.0214$). Age of immigration to the US was also significant for females ($F(2,26)=6.118$, $p=0.0202$), but neither generational group nor age of immigration was a significant predictor of aspirated-lenis f0 difference for males; see Figure 3.

Indeed, the speakers of the G1 group, who correspond to those who immigrated to the USA at a later age, have greater f0-difference values than the speakers of the G2 group, while G1.5 speakers generally fall in the middle. Second-generation female speakers were clearly not following the first-generation females in producing a pitch contrast, and male speakers did not employ a pitch contrast as much as females almost all across the board, regardless of generation or age of immigration ($F(2,11)=2.915$, $p=0.0964$). In fact, even the male speakers of the G1 group showed less of the pitch contrast than the female G1 speakers.

These results suggest that the speakers binned as G2, a proxy for second generation Korean Americans, are indeed producing these consonants differently from G1 and G1.5, which are fairly

similar to one another. The difference is much more significant for aspirated consonants than lenis consonants; the divergence is most clearly seen in how female G2 speakers do not primarily use pitch to differentiate aspirated consonants, and to a lesser degree in the way female G2 speakers produce both lenis and aspirated stops with higher VOT.

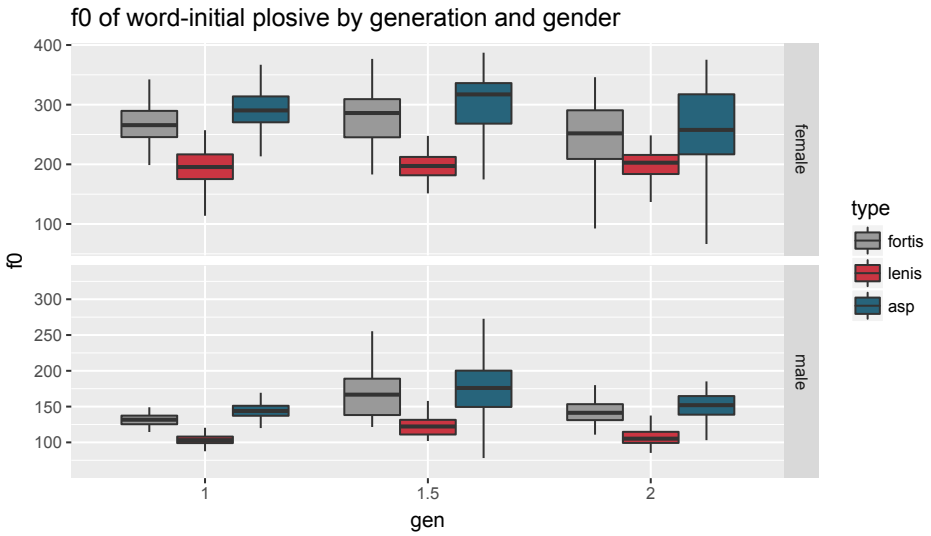

Figure 2: VOT of AP-initial stops and affricates by generation and gender.

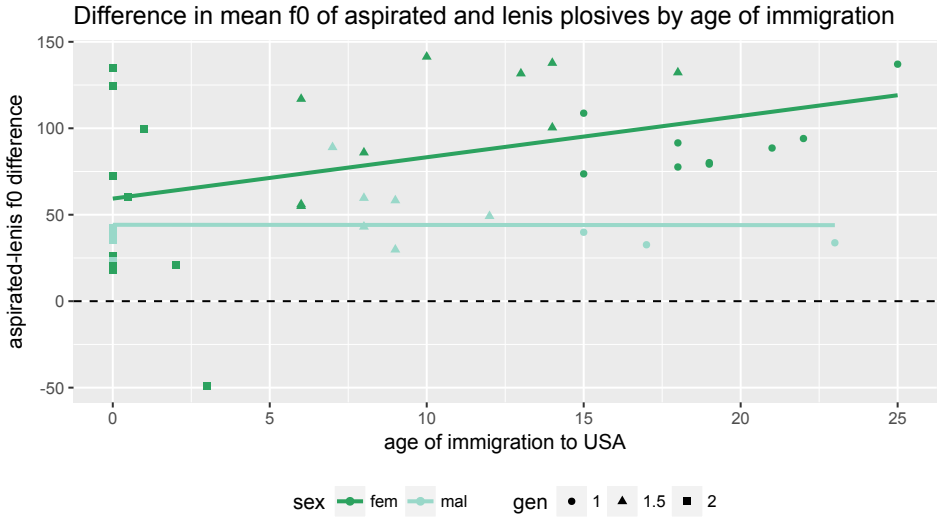

Figure 3: Fundamental frequency difference of AP-initial aspirated and lenis stops and affricates by age of immigration to USA; a significant effect of age of immigration was found for females ($F(1,20)=18.39$, $p=0.0004$), but not for males.

4 Discussion

The data indicates that the second generation female heritage speakers in particular are producing Korean AP-initial consonants with greater VOT values and less f0 contrast than the 1.5 generation

heritage speakers and first generation native speakers. In other words, the collapse of VOT contrast that is part of the ongoing Seoul Korean sound change is not occurring for second generation Korean Americans, which confirms this study's hypothesis and corroborates the findings of Kang and Nagy (2016). However, the hypothesized "heritage speakers" group that consisted of G2 and G1.5 speakers was not supported, as G1.5 patterned more closely with G1 speakers more often.

One possible explanation for this is that the sound change is still "in progress" among this population of speakers, G1.5 and G2 included. Due to considerable variability among members of each generational group, it is possible that some second generation speakers do possess the VOT merger and f0 contrast, while others do not, resulting in lower rates on average. Indeed, in Figure 3, it is possible that a handful of female speakers who immigrated early or were born in the US are pulling down the average for all female speakers.

Another explanation is that the sound change is not occurring here due to a gap in generational transfer (the "transition problem"), specifically for the second generation heritage speakers. The speakers in the G2 group are young enough that their Korean-speaking parents presumably will have acquired the variety of Seoul Korean that contains this change. However, growing up in the United States with less immersion in the Korean language may have interfered in their acquisition of stops and affricates. Put another way, acquisition of and subsequent dominance in English may affect the speaker's Korean phonology. Since English voiced and voiceless stops are primarily contrasted using VOT, second generation Korean speakers may also use VOT to distinguish between lenis and aspirated stops. In addition, Kang and Guion (2006) determined that English voiceless stops had slightly higher VOT than Korean aspirated and lenis stops (which were very similar as a result of the merger); thus, if second generation speakers map Korean aspirated stops onto English voiceless stops, this could result in the higher VOTs for Korean aspirated stops. It would be evidence of a "mixed" phonological system for the two languages of these heritage speakers. However, it must be noted that the same study (Kang and Guion 2006) argued that early sequential bilinguals, who may also be the heritage speakers with the highest speaking proficiency, maintained two distinct systems for both languages.

The language background surveys reveal that there is not nearly as much contact as one might assume between the Seoul variety of Korean and the Korean spoken by immigrant communities in California. Second generation Korean Americans grow up as Americans with exposure to Korean language and culture coming in only through limited channels. The majority of input is through their parents' idiolects, and news and entertainment media to a much lesser degree. Heritage speakers of Korean must produce Korean differently at least in part due to some amount of isolation from the changes that have been taking place in Seoul, in addition to close and early contact with English. If the sound change in question was carried across the Pacific with the large wave of first-generation Korean immigrants in the 1960s, we would have expected it to have been passed on from parent to child. We would especially expect the parents of the current study's participants to have passed it down to their children, as these parents were almost all born between 1950 and 1973 in Seoul or Gyeonggi-do and immigrated to the US in adulthood (between 1980 and 2006). Yet despite the (speculative but likely) presence of the sound change in the parents' generation and a relatively high level of exposure to Korean in the children's generation, they did not adopt it.

Additionally, it may be that there is a causative relationship between the lack of sound change in the speakers of this study and their membership in a younger age cohort when compared to past studies. The youngest subject in the Seoul corpus study (Kang 2014) was born in 1984; in comparison, the oldest subject in the current study was born in 1986. However, one cannot conclude that all young speakers of Korean (whether heritage or native) are not participating in the change, since the current study found that young native speakers in the same age cohort as the heritage speakers closely matched those in the Seoul corpus study. Speaker age is an important consideration here, but the generational identity is still the clearest locus of difference.[7]

[7]For another, closer comparison: the sample population in the Toronto study (Kang and Nagy 2016) was born between 1926 and 1992 and recorded in 2009-2011, so the youngest Korean Canadian subjects in the Toronto study were of equivalent age to the average Korean Californian subject in this study.

5 Conclusion

This study finds that second generation Korean Californians are not participating in the sound change present in the Seoul variety of Korean whereby VOT of AP-initial lenis and aspirated stops is merging and f0 of the subsequent vowel is being used as the primary means of contrast, though 1.5 generation Korean Californians and recent adult immigrants from Seoul are.

Future work on this project will expand in two directions: firstly, it will look at the other acoustic measurements of the speech data (speech rate, vowel duration, and spectral tilt, an indicator of creaky voice) and demographic information (reading fluency, parental biographical information) to look for other group differences between first, second, and 1.5 generation speakers. Secondly, it will take a deeper ethnographic dive into the lives and languages of Korean Americans and Korean heritage speakers, especially younger speakers as they acquire language and older speakers whose parents may have immigrated from Seoul before the sound change was complete (and so are for a different reason also likely not to have picked up the VOT-f0 tradeoff in their speech production).

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