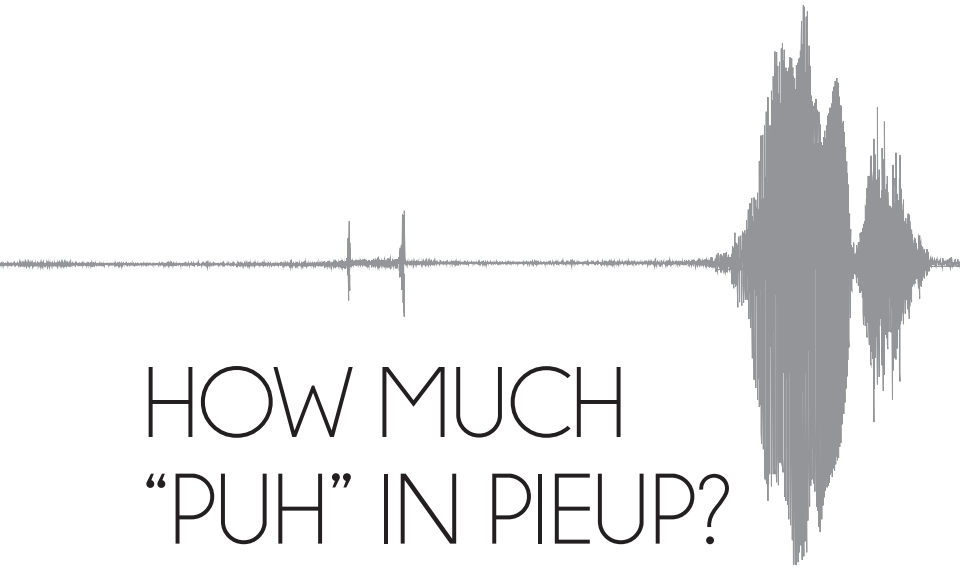

HOW MUCH "PUH" IN PIEUP?
A COMPARISON OF KOREAN ASPIRATED STOPS BETWEENL1 AND L2 SPEAKERS

Ryan Lish

While it is not uncommon for a language to have a three-way distinction between stop consonants at a single point of articulation, this distinction is typically made between voiced, voiceless unaspirated, and voiceless aspirated stops. Korean, however, is unique in that all three

kinds of stops are voiceless when they occur at the beginning of a word (Cho, Jun, and Ladefoged 2002). The three kinds of stops are therefore distinguished as fortis (or tense), lenis (or lax), and aspirated. This kind of distinction is particularly different from English, where there exists only a two-way distinction between stop consonants, voiced and unvoiced.

This difference in the phonemic inventories of English and Korean make it particularly difficult for native speakers of English to learn Korean as a second language. The difference in voice onset time (VOT) between English voiced and voiceless consonants is so drastic that it is easy for speakers of English to differentiate between words like "doll" and "tall", for example. In relation to the VOTs of English stops, Korean stops are more crowded. Korean aspirated stops have a longer VOT than English voiceless stops. Korean lenis and fortis stops both have shorter VOTs than English voiceless stops, but longer VOTs than English voiced stops (Lee and Iverson 2012).

This crowding certainly creates difficulty for English learners of Korean to both recognize and accurately reproduce Korean stops. In order to alleviate this perceived crowding, it is probable that English learners of Korean will attempt to spread the distance between the three classes of stops. This would mean that fortis stops approach English voiced stops and lenis stops would be pronounced closer to English voiceless stops. Recognizing that the Korean aspirated stop has more aspiration than the English voiceless stop, the English learner of Korean would overcompensate, pronouncing the Korean aspirated stops more forcefully than native Koreans.

This study will seek to test this hypothesis by comparing the voice onset time of English learners of Korean versus native speakers of Korean with the pronunciation of Korean aspirated stops. While there are several factors that go into the distinctions between Korean stops (Cho, Jun, and Ladefoged 2002), this study will focus on VOT to determine if English learners of Korean really do overpronounce their aspirated stops.

1. English Learners of Korean Produce Aspirated Stops with Longer Voice Onset Times

As described previously, Korean phonology maintains a three-way distinction between stops at three different points of articulation. These points are bilabial, denti-alveolar, and velar. The same three-way distinction exists for the alveolar affricate, but this study is directed solely to the stop consonants. The three classes of stops are commonly described as aspirated, lenis, and fortis. Korean is unique in that all three of these classes of stops are voiceless when they occur word-initially.

Many studies have been done analyzing this three-way distinction in various contexts (Cho *et al.* 2002, Kang and Guion 2006, Oh 2011, Broersma 2010). In each of these studies, one of the primary features measured is the voice onset time (VOT) of each kind of stop. Different measuring techniques have produced different absolute measures in milliseconds for each kind of stop, but in relative terms, the results are the same. Aspirated stops have the longest VOT, followed by lenis stops, with fortis stops being produced with the shortest VOT. Lisker and Abramson report the average VOT measured for each class of stop at each point of articulation. The ranges reported were 91-126 ms for aspirated stops, 18-25 ms for lenis stops, and 7-19 ms for fortis stops (1964).

In contrast to this, English has only two kinds of stops, voiced and voiceless. Lisker and Abramson report the VOT ranges for voiced stops as 1-21 ms, and for voiceless stops as 58-80 ms (1964). As can be seen, voiced stops in English are similar in range to fortis stops in Korean. English voiceless stops, however, lie between the ranges of lenis and aspirated stops in Korean.

There is a possibility that English learners of Korean will redistribute the VOTs of each class of stops in order to obtain a wider

amount of phonetic space. Following this model, the VOT for English voiced stops would be used to approximate fortis stops, the VOT for English voiceless stops would be used for lenis stops, and aspirated stops would be increased beyond what Korean speakers produce. Such redistribution would organize these foreign phonemes in a way that English learners of Korean could more easily distinguish between them.

It is also possible that English learners of Korean, noticing the additional aspiration in Korean aspirated stops will purposely produce their aspirated stops in Korean speech with more force than their English voiceless stops. This would potentially cause them to over-aspirate and produce longer VOTs in their aspirated stops than native speakers of Korean.

Two studies on Korean-English bilinguals produce interesting results which may support this hypothesis of over-aspiration. Lee and Iverson studied groups of children aged 5 and 10 years old who were bilingual in Korean and English or monolingual in either language (2012). The bilingual children produced aspirated stops with significantly longer VOTs than monolingual Korean speakers while they produced shorter VOTs with their voiceless stops than monolingual English speakers. The difficulty with this study is that the subjects were children, whose speech may vary from that of adults. Also, the bilingual students were exposed to both languages very early in life.

The other study was done by Kang and Guion (2006). They compared the speech production of Korean learners of English with native monolinguals of English and Korean. The Korean learners of English produced aspirated stops longer than those of monolingual Koreans. The results of this study are questionable, however, considering that the voiceless stops produced by the monolingual English speakers had longer VOTs than the aspirated stops produced by the monolingual Korean speakers. This is the exact opposite of what Lisker and Abramson reported the relation of English voiceless stops and Korean aspirated stops to be.

2. Aspirated Stops Produced by English Learners of Korean Are Not Longer Than Those Produced by Native Korean Speakers

For English learners of Korean to over-aspirate aspirated stops in Korean, it would require that they recognize Korean aspirated stops as a separate phoneme from their English voiceless stops. It is difficult for second language learners to differentiate between phonemes of two different systems if they are not introduced at an early age to the second language. "Later bilinguals may be more likely to use the same phonetic categories in both" the first and second languages (Kang and Guion 2006). While the specific age cutoff for second language learners to be able to differentiate similar sounds between two languages on a phonemic level is not agreed upon, it has been argued that it is around six or seven years of age (Lee and Iverson 2012). This would put such an ability far beyond the reach of the English learners of Korean targeted in this study, who were not introduced to Korean until adulthood. Such an argument would presume, of course, that the English learners of Korean were never explicitly told that Korean aspirated stops have longer VOTs than English voiceless stops.

A study similar to this was performed on Spanish learners of English. It was shown that native speakers of Spanish who were introduced to English as adults produced English /t/s that had significantly shorter VOT values than those produced by native English speakers (Flege 1991). The relation between Spanish-English stops and English-Korean stops is similar, because Spanish voiceless stops are significantly shorter than English voiceless stops. If the English learners of Korean in this study perform in a similar pattern, the VOT values of their aspirated stops will be longer than English voiceless stops, but they will be shorter than aspirated stops produced by a native speaker of Korean. Such a result would suggest that the English learners of Ko-

rean are unable to fully differentiate Korean aspirated stops and English voiceless stops as separate phonemes.

3. Methodology

In order to determine whether English learners of Korean overcompensate and produce stronger aspirated stops than native speakers, I measured the voice onset time (VOT) of both native speakers of Korean and English learners of Korean. The native-English speakers I focused on were students enrolled in Korean 301 or 302 at Brigham Young University who had served LDS missions in South Korea for 18-24 months and who had no experience with Korean prior to their missions. The native-Korean speakers I studied were international students at BYU. My target was to study 5-10 individuals from each group, ideally at least 3 from each gender. I anticipated difficulty with recruiting female English learners of Korean. A study by Oh shows that men and women tend to produce different VOTs (2010). If I was unable to find at least two female English learners of Korean, I would have thrown out the data gathered from female native speakers of Korean.

Being familiar with a number of Korean 301 TAs at Brigham Young University, I recruited non-native speakers from their classes. I know several Koreans and with their assistance, recruited the needed number of native speakers. A brief demographics survey (see appendix) verified that the non-native speakers had no serious introduction to Korean before their missions, and that the native speakers were from Korea. All participants were compensated with donuts.

The participants read from a list of words presented one-by-one on notecards written in Korean. Each word began with an aspirated stop at one of the three points of articulation (bilabial, denti-alveolar, velar). The words varied between one, two, and three syllables and contained various vowels. A list of words used may be found in the appendix. The speech for fifteen speakers was recorded by a Zoom

H4n Handy Recorder into 24-bit WAV files with a sampling rate of 96 kHz onto an SD card. The remaining six speakers were recorded using a Sony HDR-CX160 video camera. The sound was extracted using Audacity and converted into 36-bit mp3 files with a sampling rate of 44 kHz.

I analyzed the data using Praat. Voice onset time was measured from the stop release to the start of vocal fold vibration. The average VOT for natives and non-natives was compared at each place of articulation and overall. The significance level was 5%, meaning that if the VOT of native-English speakers was more than 5% greater than that of native-Korean speakers, the null hypothesis would be rejected.

4. Analysis

I was able to record the pronunciation of 21 speakers. Of that number, nine were native speakers of English, including 6 males and 3 females. The remaining twelve were native speakers of Korean, including 5 males and 7 females.

After collecting the data, I measured the voice onset time of each word in milliseconds and recorded it on a spreadsheet. Each speaker's overall average, as well as the averages for each point of articulation, is included in the appendix in Figure 6. The participants were grouped according to native tongue and gender, and the collective averages are displayed in **Figure 1** below. **Figure 2** shows the VOT averages for native-English and native-Korean speakers regardless of gender.

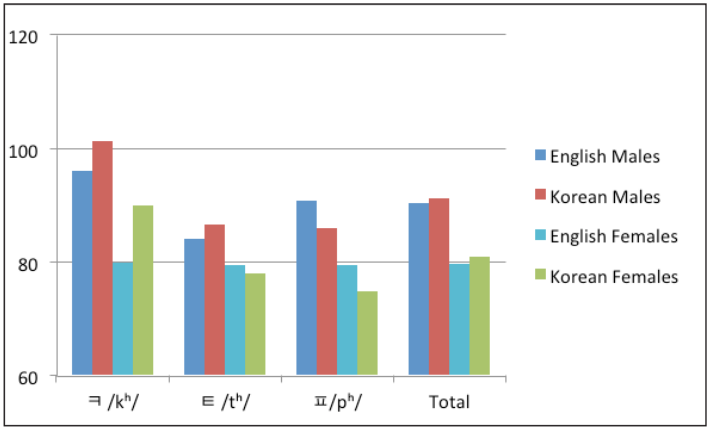

Figure 1. Average VOT According to L1 and Gender

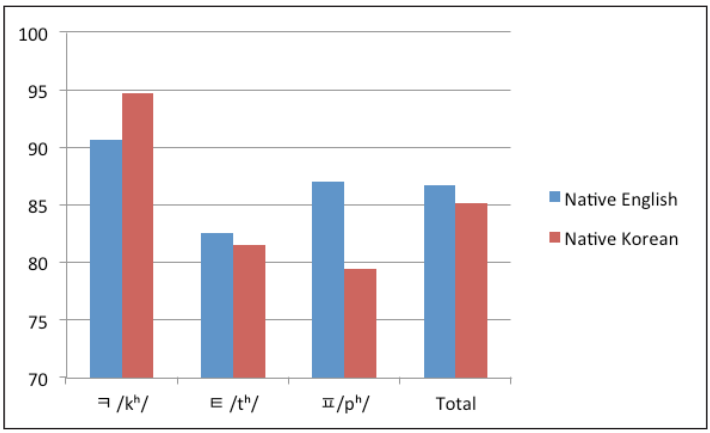

Figure 2. Average VOT According to L1

Figure 2 shows that English learners of Korean produced significantly longer bilabial stops than native speakers of Korean and slightly longer denti-alveolar stops, but shorter velar stops. Overall, the average VOT for English learners of Korean was 86.7 ms, compared to 85.2 ms for native Korean speakers. This is a difference of 1.5 ms, or 1.8% of the VOT for native Korean speakers.

The results above are simple averages, where each participant holds equal weight in the result. However, one major difficulty with this should be mentioned. As may be seen in **Figure 1**, males produced much longer VOTs than females at each point of articulation, regardless of their L1. For native Korean speakers, the ratio of male to female participants was 5:7, whereas for English learners of Korean, it was 2:1. The results for native Korean speakers were skewed toward females, which resulted in a lower average. The male majority of English learners of Korean resulted in a higher average than would be observed if both genders were equally represented.

Rather than discard data to give each gender equal representation, I computed averages separately for males and females according to their L1. These are the results displayed in **Figure 1**. From these averages, I computed the averages according to L1 so as to give each gender, rather than each participant, equal weight in the results. These results are shown in **Figure 3**.

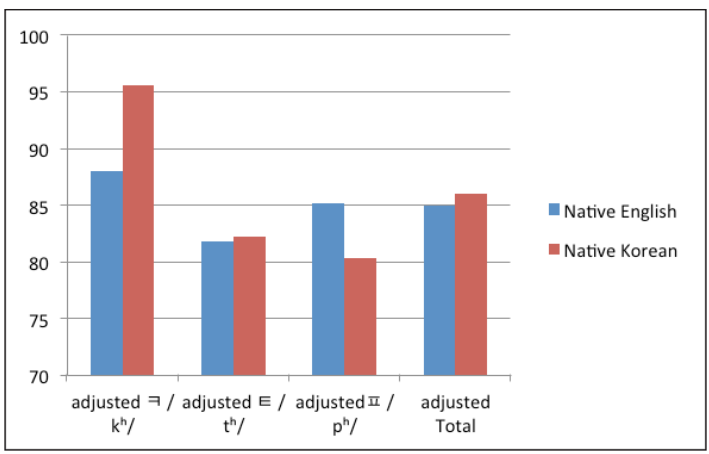

Figure 3. Average VOT According to L1 (Adjusted to Equalize Genders)

As may be seen, the VOT for English learners of Korean were decreased at all points of articulation, while they were increased for na-

tive Korean speakers. The adjusted total for English learners of Korean becomes 85.0 ms, compared with 86.1 ms for native Korean speakers.

5. Conclusion

After reviewing the data, and making the necessary adjustments to account for gender differences, it appears that English learners of Korean do not over-aspirate their Korean aspirated stops. Considering that their average VOT was 1.1 ms shorter than the VOTs produced by native Koreans, English learners of Korean do not exceed the threshold of significance, which requires that they produce VOTs 5% longer than those of native speakers.

The obvious implications of a study such as this are directed toward L2 acquisition. If my hypothesis had turned out to be true, teachers of Korean as a foreign language (KFL) would be able to tell their students to slightly reduce the emphasis they put into producing aspirated stops. By doing so, they would produce stops with VOTs closer to those produced by native speakers.

My hypothesis was rejected, however, so KFL teachers do not necessarily need to advise any major adjustments to their students, especially considering the overall difference in averages was a little over 1 millisecond. Breaking it down by place of articulation, however, a KFL teacher may recommend that English learners of Korean shorten their bilabial stops and lengthen their velar stops in order to sound more authentic.

In regard to the larger issue at hand, the results do not support the idea that English learners of Korean rearrange the VOTs of Korean stops to maximize their phonetic space. This raises the question of how English learners of Korean produce lenis and fortis stops in relation to Korean speakers. Either they are able to learn to recognize and reproduce the differences in stops within the native Korean amount of phonetic space, or they adjust the VOTs of lenis and fortis stops

downward to create more phonetic space. But that is something to be researched in a future study.

There were numerous weaknesses in this study that must be mentioned. First of all, my sample size was extremely small and limited in scope. Nine students enrolled in Korean 301 at BYU, all of whom learned Korean on an LDS mission in South Korea, can hardly be used to represent all English learners of Korean. A better sample would include those who learned Korean in different ways and who studied at different schools. I intended on using only Koreans from Seoul, but due to lack of availability, I had to open it up to anyone from Korea. These other Koreans may have had dialectal variations affecting the results. It was stated earlier that a study by Kang and Guion showed Koreans who speak Engish produce longer VOTs than monolingual Koreans (2006). All the Koreans in my study were bilingual, so their pronunciation may have been influenced by their L2. It would have been better if I had been able to gather my data from Koreans living in Korea. Also, if I had greater resources, I would have collected data from a much larger pool of participants.

Since the participants were prompted to read from notecards one word at a time, this may have affected their pronunciation. In such citation form, the words may have been enunciated more clearly than they would have been in regular speech, but since all the speakers were using citation form, this should not have had a large impact on their relative voice onset times.

6. Future Work

Due to the limited scope of this study, there are many other studies that could be performed in order to further research in this area. Firstly, further research could be conducted to analyze fortis and lenis stops produced by English learners of Korean in comparison with those produced by native speakers. This would complete the picture of how

English learners of Korean cope with having three classes of stops in the amount of phonetic space they usually have for two.

Another useful study would compare the English and Korean stops produced by bilingual native speakers of English. Such a study would show if English learners of Korean pronounce their Korean aspirated stops significantly longer than their English voiceless stops. This would show whether the English students of Korean are able to distinguish the Korean stops as different phonemes from those of English.

Finally, English learners of Korean from a single skill level were selected for this study. A more comprehensive study would measure the stops produced by learners of Korean at various skill levels, from beginner to advanced. This kind of study would show if the VOTs of the different classes of stops shift according to the speaker's skill level. Alternatively, a longitudinal study could be performed to measure the same group of participants over time to track individual changes. This study, along with the others mentioned here could help linguists and those studying Korean as a second language to gain a better understanding of the language acquisition process, particularly as it relates to phoneme acquisition.

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Appendix A

Participant Survey

1. Age:
2. Gender (circle one): M / F
3. What is your native language?
4. If your native language is English, how long have you studied Korean?
5. If your native language is English, where did you learn Korean?
6. If your native language is Korean, where in Korea were you raised?

Appendix B

Figure 5. List of Korean Words

ㅍ /pʰ/	ㅌ /tʰ/	ㅋ /kʰ/
팔 /phal/ 'arm'	탈 /thal/ 'mask'	칼 /khal/ 'knife'
품 /phwum/ 'chest'	투자 /thuca/ 'investment'	쿵 /khwung/ 'palace'
포기 /phogi/ 'a head of cabbage'	토끼 /thokki/ 'rabbit'	코 /kho/ 'nose'
피 /phi/ 'blood'	팀 /thim/ 'team'	키 /khi/ 'height'
퍼지다 /phecida/ 'to spread out'	터지다 /thecida/ 'to explode'	커지다 /khecida/ 'to become larger'
파다 /phada/ 'to dig'	타다 /thada/ 'to ride'	카드 /khadu/ 'card'

Appendix C

Average Results for Each Participant

Participant	1	2	3	4	5	6	7
K/E*	K	E	K	K	E	E	E
Gender	M	M	F	M	F	M	F
ㅍ /pʰ/	99.17	78.67	80.00	93.33	68.83	110.17	76.17
ㅌ /tʰ/	84.33	63.83	75.17	78.50	77.50	99.67	76.50
ㅋ /kʰ/	89.33	80.50	67.67	67.67	80.50	102.33	67.83
Total Average	90.94	74.33	74.28	79.83	75.61	104.06	73.50

Participant	8	9	10	11	12	13	14
K/E	E	E	K	E	K	K	E
Gender	M	M	F	M	M	F	F
ㅍ /pʰ/	78.50	89.50	132.33	115.83	97.33	114.33	94.83
ㅌ /tʰ/	74.00	71.00	121.17	97.00	85.67	98.50	84.33
ㅋ /kʰ/	79.67	77.50	107.17	100.83	83.83	89.00	90.17
Total Average	77.39	79.33	120.22	104.56	88.94	100.61	89.78

Participant	15	16	17	18	19	20	21
K/E	E	K	K	K	K	K	K
Gender	M	F	F	F	M	F	M
ㅍ /pʰ/	103.33	63.00	77.33	78.17	117.33	84.33	99.33
ㅌ /tʰ/	99.17	55.00	70.50	60.17	98.67	64.50	85.50
ㅋ /kʰ/	103.83	59.33	75.33	58.83	105.83	66.00	83.00
Total Average	102.11	59.11	74.39	65.72	107.28	71.61	89.28