

RELEARNING HERITAGE LANGUAGE PHONOLOGY

by

COURTNEY ANN MACER

(Under the Direction of Margaret Renwick)

ABSTRACT

Theories of language acquisition support the idea that experience in a language during early childhood is crucial to developing native-like phonology in that language. However, less support exists for the idea that these benefits persist into adulthood if speaking is nearly or totally discontinued after childhood. The present study aims to evaluate the accessibility and potential for re-learning native-like phonology during adulthood after a long period without spoken experience in the target language. Using a methodology loosely adapted from Oh et al.'s (2003) study, perception and production of Korean sounds by native speakers of Korean were compared to those of adult heritage speakers, childhood heritage speakers, and second language speakers. Each non-native group of participants was enrolled in college Korean language classes, subdivided into "novice" and "experienced" instructional levels. The results indicate that heritage speakers became native-like in their perception and production of Korean tense and lax stops more quickly than non-heritage speakers.

INDEX WORDS: Heritage language, Second language acquisition, Language learning, Phonology, Native-likeness, New theory of disuse, Storage strength, Retrieval strength, Critical period hypothesis, Korean.

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DEDICATION

To my parents, for their encouragement and wisdom

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CHAPTER 1

INTRODUCTION

A recently popular area of linguistic research has involved populations of “heritage” language speakers and the nature of their linguistic competencies in the heritage language. While the parameters for what qualities distinguish a heritage speaker from other types of language speakers are often poorly defined, for the purposes of this thesis a heritage speaker is, at a most basic definition, a speaker who has some level of non-majority language competency stemming primarily from interaction with one or more family members who are native speakers of that language. The resulting linguistic competencies of heritage speakers vary from native speaker competencies to different degrees depending on factors such as age of onset, continuity of exposure, and quality of language use.

Although most heritage speakers have the early phonological experience considered necessary to acquire native-like phonology in a language, many discontinue speaking the language once immersion in the community language begins during childhood, typically with the start of public schooling. In this thesis, such individuals will be referred to as “childhood heritage speakers,” while heritage speakers who did not experience a discontinuity in speaking experience will be referred to as “adult heritage speakers.” It is still unclear whether speaking experience that is limited to early childhood, as in childhood heritage speakers, provides lasting benefits for the accents of speakers who have begun relearning their heritage language as adults.

Understanding the impact of childhood speaking experience on the potential quality of the resulting accent in adulthood is significant because such knowledge will help families and school systems formulate policies that act in the best interests of children who are raised in homes where a heritage language is spoken. While many public schools in the United States encourage an “English-only” policy on campus, discouraging or shaming use of a heritage language at school may harm the child’s ability to maintain native-like phonology in their heritage language into adulthood. Conversely, if native-like phonology in a heritage language can easily be relearned in adulthood provided the speaker had childhood speaking experience, parents in homes where a heritage language is spoken may be encouraged to less stringently enforce use of the heritage language in the home if their child becomes more comfortable with English. More broadly, this topic is also important because it may lend itself to a better understanding of the nature of language acquisition during the critical period.

In order to examine the issue of whether or not speaking experience in early childhood contributes to higher potentials for learning and native-likeness in adulthood, I measured perception and production of Korean sounds by native speakers of Korean as compared to those of adult heritage speakers, childhood heritage speakers, and second language speakers. Each non-native group of participants was enrolled in college Korean language classes, subdivided into “novice” and “experienced” instructional levels. The purpose of this study was to investigate whether childhood heritage speakers hold a higher potential for attaining native-like phonology in their heritage language than do second language speakers with similar levels of instruction in Korean. I hypothesized that childhood heritage speakers would improve more quickly than second language

learners by becoming more native-like after prolonged formal instruction. In addition, I hypothesized that adult heritage speakers' accents would not be significantly different from those of native speakers. Such results would support the idea that not only childhood speaking experience, but also recency and continuity of language use, impact an individual's potential for speaking with a native-like accent in adulthood.

This thesis contains five chapters. In Chapter Two, I provide an overview of literature on theories of language memory and heritage language relearning and outline methodologies used in studies on heritage language relearning. Chapter Three covers the methodology for the current study. In Chapter Four, I provide an analysis of the data from each task before summarizing the findings and exploring implications of the study in Chapter Five.

CHAPTER 2

LITERATURE REVIEW

In order to approach the topic of relearning heritage language phonology from childhood language experience, it is necessary to first explore the issues of age of phonological acquisition, heritage speakers as a diverse speaker group, and theories about the human memory as it pertains to language and the ways in which they intersect. In addition, provided in this chapter are an outline of the major acoustic properties of Korean stops as well as an overview of Oh et al.'s (2003) study, from whose methodology this study has been designed.

HERITAGE SPEAKERS

While the Critical Period Hypothesis proposed by Carl Lenneberg (1967) is today widely considered far too rigid to account for the many intricacies of language acquisition, its main idea—that there exists some period in childhood during which language acquisition occurs in a native-like manner without explicit instruction—still finds broad support. Aitchison (1989) summarized the basic idea of a critical period quite succinctly as “the fact that younger brains are more flexible than older ones” (p. 89). For phonology in particular, this crucial period in which phonemic distinctions from non-native languages are discarded in favor of distinctions between phonemes in the native language occurs by one year of age (Werker 1984). Following these ideas, heritage language speakers who were exposed to their heritage language since infancy should theoretically possess intuitive knowledge of phonemic distinctions in that

language. Further, if exposure during infancy is truly the one critically important factor for acquiring phonemic distinctions, then discontinuity of language exposure after the critical period should not significantly disturb this knowledge. In support of this notion, findings by Oh et al. (2003) indicate that heritage learners of Korean who had only overheard and not produced Korean, and only during childhood, were still able to perceive a three-way distinction in Korean plosives as adults.

The above description of a group of heritage language learners who had never spoken their heritage language provides us an easy transition into considering what, exactly, defines a heritage speaker. Wiley (1999) explores a number of the ambiguities that surround the term. First, because heritage languages carry a connotation of either ethnic or ancestral identity, it becomes difficult to discern which part of a person's identity—linguistic or ethnic—qualifies them as a heritage language learner. Whereas ethnic identity may be relevant in the case of attempted linguistic revivals (i.e. indigenous languages), it is less pertinent to the discussion of immigrant languages. For the purposes of this study, someone with only ancestral connection to a language, but no linguistic familiarity with it, is not termed a heritage speaker.

Even shedding the issue of ethnic identity as it relates to heritage speaker identity, the range of linguistic experiences of heritage speakers is as incredibly varied as the family histories and linguistic environments that accompany them. Thus, the problem of what constitutes familiarity with a language remains. While some heritage speakers enjoy early exposure to their parents' language and maintain competency in that language continuously into adulthood, others' early competencies in their heritage language atrophy once immersion in the community language begins in late childhood, typically

with the start of public schooling. Still others experience very little or only passive early exposure to the heritage language, but for various motivations choose to attempt to learn the language later on. Despite such an apparent, wide variation in the linguistic experiences of heritage language speakers, public perception and educational policy still tend to pigeonhole this diverse population of speakers into one “heritage” category.

The search for a definition that can encompass all of these types of speakers finds success with Valdés (cited by Wiley 1999, p. 35), who provides a definition that Wiley finds useful: a heritage speaker is someone who was “raised in a home where a non-English language is spoken” and “who speaks or merely understands the heritage language, and who is to some degree bilingual in English and the heritage language.” For the purposes of this thesis, however, I will employ an even simpler definition: a heritage speaker is someone who has some level of non-majority language competency stemming primarily from interaction with one or more family members who are native speakers of that language. In the present study, I deal only with heritage speakers whose familiarity with their heritage language was first established before school age.

ROBERT A. BJORK’S NEW THEORY OF DISUSE

One cognitive theory about memory and forgetting that informed Oh et al.’s (2003) study and has implications for the present study is Robert A. Bjork’s New Theory of Disuse (1992, 1996). The New Theory of Disuse has at its crux the notion that knowledge involves different types of memory, namely *storage strength* and *retrieval strength*. *Storage strength* deals generally with how well an item in memory has been learned, but not with its performance. *Retrieval strength*, on the other hand, deals with an individual’s ability to retrieve stored information for current use. In theory, retrieval

strength weakens over time with disuse, which is why even information that was once used almost daily and for a long period, such as a childhood address, may be difficult to recall years later (R. Bjork & E. Bjork, 1992, 1996). While failing to recall outdated or irrelevant information may actually be an adaptive strategy of human memory that makes our retrieval of more recent items less competitive, a weakening of retrieval strength for a language used in childhood, while also adaptive, is far less desirable because it subtracts from a communicative resource that may be needed in the future.

The concepts of storage and retrieval strengths intersect relatively neatly with a number of formal linguistic concepts, including the ideas of acquisition and performance and the critical period hypothesis. Storage strength relates to acquisition of linguistic skills, and retrieval strength ties in more closely with performance. It is worth noting that “performance” here is not synonymous with production. Even comprehension requires the performance of some perceptive skill that would exercise the mental muscle of perceptive retrieval strength.

Bjork performed additional research on how order of onset of information affected retrieval strength. He found that, after some delay, subjects who were tasked with remembering items from a list changed from being able to recall the most recent items (recency) to being able to recall the first items presented (primacy) (Bjork & Whitten 1974). What we know about the critical period hypothesis in linguistic research, which posits generally that languages learned earlier in life are learned more completely and naturally, may intersect well with these ideas of time of information onset and storage strength; perhaps skills learned during the critical period have higher storage strength attached to them. For example, if a child receives regular exposure to a second

language during the critical period for phonology, that child may retain native-like phonological perception for that language into adulthood owing to their high storage strength, as long as they have had enough recent experience with the language to rebuild their retrieval strength for those perceptual abilities. Such a speaker might have an advantage over someone with similar recent experience with the language who did not have early exposure (and thus high storage strength).

If Bjork's New Theory of Disuse extends to the realm of language acquisition, then speakers who are not proficient in their heritage language as adults may still harbor significant linguistic knowledge about aspects of that language that were learned in childhood. In these cases, such adults who have previously held knowledge of the heritage language but who are seemingly incapable of applying that knowledge in adulthood might be described as having strong storage strength but weak retrieval strength in those areas. That is, the necessary information is there, but on the surface can appear to be absent due to poor retrieval strength caused by years of disuse.

One study that may hold implications for storage versus retrieval strength with further research is Pallier's (2001) study of Korean children who had been adopted to France between the ages of three and eight years old. After adoption, the children became monolingual French speakers. Despite the relatively late age of first exposure to French and significantly rich monolingual input in Korean well into the time that the children had begun to speak, fMRI patterns showed that the adoptees showed no more recognition for Korean than did monolingual French speakers with no previous exposure to Korean.

Under R. Bjork & E. Bjork's (1992, 1996) model detailing storage and retrieval strength, this would mean that the adoptees' retrieval strength for recognizing the phonology of Korean had atrophied to imperceptible levels after years of complete disuse. However, such subjects would theoretically still have strong storage strength for linguistic knowledge of Korean. It is worth noting that most similar studies have sought to measure retrieval strength for childhood languages involving subjects who did not experience total discontinuation of use of the language past childhood. For example, in Tees & Werker's (1984) study, some such subjects who had been exposed to Hindi during infancy continued to hear Hindi-accented English in Hindi communities in Canada, even after they discontinued use of the heritage language itself. Even hearing accented English regularly may have preserved phonological retrieval strength for the participants involved in this study.

Older studies have used age-regression hypnosis as a way to examine lingering storage strength even in the absence of retrieval strength (Ås 1962; Fromm 1970). Such studies found that childhood language memory did become accessible under such conditions, which seems to lend support to R. Bjork & E. Bjork's (1992, 1996) models of storage and retrieval strength in linguistic memory.

KOREAN PHONOLOGY

To fully understand two important studies from whose methodology my own study was designed, it is necessary to have a basic understanding of some aspects of Korean phonology. Korean exhibits a three-way contrast among stop consonants—tense, lax, and aspirated—all of which are voiceless in word-initial position (Choi 2002). The only exception is that lax stops become voiced intervocally. Each of these three types

of stops can occur at three different places of articulation: bilabial, denti-alveolar, and velar (Cho et al. 2002). Two major distinguishing factors between the three types of stops are VOT and f_0 of the following vowel. While mean VOT does distinguish the three-way contrast, with tense stops having the shortest VOT, lax stops having an intermediate VOT, and aspirated stops having the longest VOT, the VOT ranges for each type of stop overlap significantly (Lisker & Abramson 1964). For tense and aspirated stops, f_0 is relatively higher (high tone), whereas for lax stops it is lower (low tone); however, as a whole, Korean is not a tonal language. The difference in f_0 of the following vowel supplements the information provided by VOT to aid identification of phonemes (Han 1998). In addition to VOT and f_0 of the following vowel, other, less obvious acoustic properties, such as duration of stop closure, amount of linguopalatal contact, laryngeal and supralaryngeal articulatory tension, and degree of glottal opening also vary among Korean stop types (Cho et al. 2002).

RELATED STUDIES

The two studies whose methodologies inspired the present study and which have dealt specifically with phonological memory after childhood in heritage learners based on the type of childhood input are Oh et al. (2003) and Knightly et al.'s (2003) studies on Korean and Spanish heritage language re-learners. The study by Oh et al. (2003) involved a perception task in which participants heard a word from a minimal triplet of denti-alveolar stop consonants reflecting the three-way contrast in Korean plosives. The words were presented in isolation and participants were asked to choose which word they heard.

The perception task methodology strikes me as problematic for two reasons. First, as was presented above, VOT values for Korean stops are not an entirely reliable measure of perception on their own because the values overlap significantly with one another. Second, without a frame sentence around the stimulus by which participants could familiarize themselves with the pitch of the speaker's voice, their ability to rely on f0 as a supplemental distinguishing factor for Korean stops was likely severely handicapped. Hearing only one word from the minimal triplet in isolation did not provide enough context for participants to perceive whether any one word had a vowel that was at a higher f0 for that speaker. If a frame sentence had been included, participants may have been able to use f0 as a supplemental perceptual cue.

In addition, while some of the results between the two studies were divergent, I believe that the composition of the participant groups was at play. The results showed Spanish heritage overhearers able to both perceive and produce Spanish plosives accurately, while Korean heritage overhearers were only able to perceive, but not produce, the three-way Korean stop contrast (Oh et al. 2003). The researchers postulated that the difference between the results of the two studies might have originated from the fact that the three-way stop contrast in Korean may simply be harder to learn than the two-way contrast in Spanish, or that the two groups of participants were different in that the Spanish heritage re-learners had already been taking Spanish classes for four years at the time of the study compared to the Korean re-learners' four months of language classes. Viewed through the lens of Bjork's New Theory of Disuse, the Korean participants had not yet had sufficient instruction to rebuild retrieval strength of their

phonological production abilities. The problem of insufficient retrieval strength begs to be explored further.

While Oh et al. (2003) and Knightly et al. (2003) found that childhood speakers of the heritage language who discontinued its use after beginning schooling were reliably able to perceive and produce phonology in a native-like manner, my own experience with childhood heritage speakers suggests that many of them consider themselves to have an accent in their heritage language. I would not consider this sentiment unfounded, but an analysis that only deals with VOT values may at least superficially seem to refute it.

Based on the absence of f_0 as a factor in the perception and production tasks in Oh et al. and Knightly et al.'s studies, I would not consider the results as entirely representative of the native-likeness of heritage speaker accents. In view of this, the present study aims to more completely examine the native-likeness of heritage speaker phonology by considering perception and production not only of VOT, but also of f_0 of the following vowel. In addition, only tense and lax (and not aspirated) stops are used as stimuli and more experienced students were recruited in addition to novice students. These two adjustments were made in order to better align the results with Oh et al.'s (2003) Spanish data, which included only a two-way stop contrast and some participants who had been enrolled in Spanish classes for four years. These adjustments should yield data that better accounts for the Korean data.

CHAPTER 3

METHOD

RESEARCH QUESTIONS

The present study aims to address the native-likeness of heritage speaker perception and production of Korean phonology while considering both VOT and f0 of the following vowel. In order to approach this problem, the following questions must be addressed: Does reliance on VOT or f0 as perceptual cues vary by speaker group? If so, how do different speaker groups vary from the native speaker control group in their reliance on VOT or f0 as perceptual cues? Do different speaker groups use VOT or f0 to produce the difference between tense and lax stops in Korean? If so, how do different speaker groups vary from the native speaker control group in their reliance on VOT or f0 to produce the difference between tense and lax stops in Korean? Finally, for each speaker group, does novice or experienced level of instruction affect reliance on VOT or f0 as perceptual cues or for production?

PARTICIPANTS

The present study, conducted in the fall semester of 2014, tested 52 adult students of Korean between the ages of 18 and 24 who were enrolled in college Korean courses at the University of Georgia, Emory University, or Georgia State University in the fall semester of 2014. Three speakers' language backgrounds were not conducive to analysis and were excluded from the analysis, leaving a total of 49 participants, of whom 11 were male and 38 were female. In addition, nine native speakers of Korean, most of whom

were also enrolled in Korean classes at these same universities, were tested as a control group. It is not uncommon for native speakers of a language to enroll in a course that teaches their native language in order to more easily satisfy foreign language credit requirements at their university. Students were identified as native speakers based on their responses to the language background questionnaire.

The 49 participants studying Korean were classified into one of three groups: adult heritage speakers, childhood heritage speakers, and second language speakers. These groups were operationally defined as follows: (a) an adult heritage speaker is bilingual in English and Korean, and who has used their heritage language continuously since childhood; (b) a childhood heritage speaker was bilingual in English and Korean at some point during childhood, but substantially declined or completely stopped their Korean language use; (c) a second language speaker is a native speaker of English who had no exposure or connection to Korean during childhood and began formally learning Korean in college. These three groups of participants were further subdivided into two instructional levels: “novice” (less than one year of college-level instruction in Korean) and “experienced” (one or more years of college-level instruction in Korean). In total, including the native speaker control group, seven groups were formed from the 59 total participants. The counts of participants in each student group are presented in Table 1.

Table 1: Participant distribution by group type

	Adult Heritage	Childhood Heritage	Second Language
Novice	7	7	16
Experienced	1	3	15

While individual university class schedules varied, students in first or second semester Korean classes typically met for approximately 200 minutes of instruction per week while students in third or higher semester Korean classes typically met for approximately 150 minutes of instruction. However, participants were classified as novice or experienced based on how many semesters of Korean classes they had taken, not by the level of class in which they were enrolled. Participants were classified this way because the study aims to examine the effect of quantity of recent exposure, not the effect of assessed proficiency. Some heritage speakers of Korean place into advanced course sections even for their first semester of Korean instruction. Therefore, instructional time for participants varied on an individual basis and is not expected to influence results.

DATA COLLECTION

The three-part experiment was conducted in a quiet location, typically in a study room or sound booth, and took about thirty minutes for each participant to complete. First, the participant was asked to complete a questionnaire that asked questions about their past and current language use as well as their level of formal instruction in Korean. The answers to the questionnaire (see Appendix A) were then reviewed with the participant. Each participant was asked further questions as necessary in order to categorize themselves into one of the seven participant groups. Commonly, participants were asked about their nature of exposure to Korean, especially if the age of onset was neither during early childhood nor during college. In addition, participants were sometimes asked whether they would feel comfortable using Korean in Korea in either informal or formal settings.

Next, the participant was presented with a list of twelve sentences written in Korean (see Appendix B) and asked to read the list of sentences aloud three times at a comfortable pace into a microphone in order to measure their production of VOT and f0 values for syllables containing tense and lax stops. Each participant was given a short explanation and an example of creaky voice as a sound that the microphone would not record well to ensure analyzable recordings. The sentences that the participant was asked to read consisted of simple frame sentences (i.e. *CV-ga teol^ha* ('*CV is good*'); *igΛs^h un CV-da* ('*this is a CV*')) into which CV syllables beginning with either tense or lax consonants at three different places of articulation (labial, denti-alveolar, and velar) were strategically placed. Only those target syllables that occurred phrase-initially were chosen for analysis because an intervocalic placing of a lax stop would have yielded a voiced stop, which would have provided a perceptual cue extraneous to VOT and f0 of the following vowel. Other sentences in which target syllables were not phrase-initial served as distracter sentences to avoid list intonation. Six target sentences repeated three times yielded eighteen tokens from each participant; each unique tense or lax stop had three tokens.

The vowel in all CV target syllables was the low front vowel /a/ to avoid effects of the vowel qualities on phonetic measurements relating to the target consonants. Finally, while efforts were made to ensure that each target syllable was a nonce word in order to prevent giving adult heritage speakers an advantage based on their knowledge of conventional pronunciations of known Korean words, the nature of the Korean lexicon made it unavoidable that the syllables chosen would have meaning in Korean. However, insertion into the sentences rendered the target syllables nonsensical because they were

detached from their conventional uses and grammatical structures, so word recognition was not expected to interfere with results.

The third and final task was a computer-based, phoneme identification task run in the linguistic software Praat designed to assess participants' abilities to differentiate the two-way [\pm tense] contrast between tense and lax stops in Korean. To create the stimuli for this task, a female native speaker of Korean was recruited to read a number of sentences beginning with tense or lax stops. The sentences beginning with lax stops were then manipulated using Praat to change values for voice onset time (VOT) and pitch (f_0) of the following vowel. To change VOT values, small portions of the sound file were deleted from the period containing aspiration. To change f_0 , a pitch tier at the desired pitch was applied to the original recording.

Four VOT values (8, 25, 43, and 60 ms) were used, based on the average tense (8 ms) and lax (60 ms) VOT values as well as two intermediate values. Four f_0 values (200, 225, 250, and 275 Hz) were also used, again based on the native speaker's average f_0 for vowels following tense (275 Hz) and lax (200 Hz) stops with two other intermediate values. The manipulation of the native speaker's recordings of lax stops, using four VOT and four f_0 values, yielded sixteen stimuli for each of the three places of articulation (labial, denti-alveolar, and velar).

In addition, to account for the possibility that cues outside of VOT and f_0 would influence participants' perception, the recordings of tense stops produced by the native speaker were also manipulated. However, these recordings did not sound as natural after manipulation, so only the f_0 of the following vowel was manipulated for the native speaker's recordings of tense labial and denti-alveolar stops. The manipulation of tense

stop recordings yielded stimuli at a VOT of 8 ms each, distributed among four f0 values (200, 225, 250, and 275 Hz) among labial and denti-alveolar places of articulation, for a total of eight stimuli sourced from recordings of lax stops. Because each stimulus was presented twice during the perception task, participants heard a total of 112 stimuli.

During the task, each participant heard a CV syllable similar to the ones from the production task followed by an invariant frame sentence (*CV-tei mas^hejo* ('don't do X')). The frame sentence served to contextualize the f0 of the target syllable against the natural pitch of the recorded native speaker's voice. Again, the vowel for the syllables was invariably /a/. The sentence was played through headphones worn by the participant, who was then asked to distinguish which phoneme they heard at the beginning of the sentence. Each participant was instructed to disregard any possible semantic meaning of the target syllables. The participant was able to press a button to repeat each sound up to three times before making their choice.

Response choices were the tense and lax versions of each place of articulation, written out in the Korean script of *Hangul*, which all participants were familiar with through their classroom Korean instruction. Using *Hangul* for the task was advantageous because Romanization systems have inconsistent and unspecific methods of representing tense and lax stops, which do not occur naturally in English. After choosing between a tense and lax answer, the participant was asked to indicate how confident they were about their choice on a scale of one through five.

The perception and production tasks were intended to give a complete picture of a participant's native-likeness for perception and production of tense and lax stops in Korean. Further, the order in which tasks were completed, with production before

perception, ensured that participants did not receive native models of production as cues immediately before producing the sounds themselves. The results from these two tasks, coupled with the information that the participants provided during the questionnaire regarding their history of exposure to and production of Korean, provided a platform from which the effects of childhood language experience could be analyzed.

CHAPTER 4

RESULTS AND ANALYSIS

TASK I: QUESTIONNAIRE

The results from each questionnaire were analyzed and categorized during the session with the participant so that further questions could be asked if necessary.

Answers on the questionnaire that prompted further questions typically related to age of onset or a participant reporting low speaking proficiency despite identifying Korean as a native language. If the age of onset was neither during early childhood nor during college, participants would be asked about the nature of first exposure to Korean.

A common follow up question explored whether a participant would feel comfortable using Korean in Korea in either informal or formal settings, and whether the participant felt that their accent or language patterns when speaking Korean would mark them as obviously from the Korean Diaspora to listeners from Korea. These follow up questions cleared up discrepancies between participants' reported speaking proficiencies and their identification of Korean as a native or heritage language. In situations where these two sets of answers did not make a participant's heritage or native speaker status obvious, the above questions provided simple clarification.

Participants who indicated that their accent or language patterns would mark them as belonging to the Korean Diaspora were classified as heritage speakers, as were speakers who expressed that they felt unprepared by their previous language use to speak Korean in a formal setting (such as a university course or Korean business office).

Categorizing speakers by their answers to this follow up question makes sense given our knowledge of the nature of heritage speakers' language use. Heritage speakers of any type typically use their heritage language in their home or among friends, both informal settings. It follows that their comfort level with using their heritage language in formal settings would be relatively low, especially in a language like Korean that makes use of an intricate system of honorific rules.

Finally, participants were categorized as childhood heritage speakers if they indicated that their past proficiencies in modes of Korean language use were higher than their current proficiencies. The questionnaire fortified this report by also asking which languages the participant spoke before the age of five, after the age of five, and after the age of ten. Participants who were childhood heritage speakers typically removed Korean from the list of languages that they spoke after age five or ten. In the case that responses did not make it clear that a participant was a childhood heritage speaker, the researcher followed up with a question asking about current language use in the home. Participants who were categorized as childhood heritage speakers typically described home language use patterns in which parents spoke to their children in Korean while children responded to parents and talked amongst themselves in English.

Based on questionnaire responses, only three participants were disqualified from analysis. Two participants identified neither English nor Korean as their native languages; it is beyond the scope of this study to account for the rates at which non-native speakers of English learn Korean phonology. A third participant was not included in results because their language background was inconclusively heritage or native. The participant in question had spent various portions of childhood in the United States and

Korea, with wide variations in home language use during each period. Citing their language background, the participant said that they did not feel like a native speaker of either language. Because it was unclear how this participant's language background would affect their production and perception, their results were removed from analysis.

In sum, the crucial data collected by the questionnaire were age of onset, level of instruction in Korean, and heritage speaker status. These three pieces of information were sufficient to classify participants into broad categories based on their past and language experiences.

TASK II: PRODUCTION TASK

The data produced by the nine native speaker participants during the production task served as benchmark data by which all other groups were assessed. Compiling production data from college-age native speakers was crucial because it provided data on VOT and f0 of tense and lax stops by speakers in the same age group as the Korean language student participants, which controlled for possible generational differences in VOT and f0 during tense and lax stop production.

VOT Production Across Speaker Types and Levels

Using Praat, VOT was measured from the beginning of the burst to the beginning of voicing. VOT data from all participants is shown in Table 2. VOT values for lax stops were consistently shorter in male participants than in females. Unfortunately, very few males participated in the study, so the data from males is less meaningful here than corresponding data from female participants. In addition, data from experienced childhood heritage females in this study must likewise be considered relatively unreliable given the small number of participants in this category.

Table 2: VOT Data

Group	Level	Gender	Tense VOT in ms				Lax VOT in ms			
			Mean	SD	Min	Max	Mean	SD	Min	Max
Native Speaker	-----	F	12.73	7.09	3.43	35.99	72.09	15.03	36.33	106.06
		M	13.12	8.95	3.57	41.95	50.04	19.01	22.22	90.95
Adult Heritage	Novice	F	15.31	12.30	1.69	68.59	77.96	20.32	20.29	120.80
		M	17.30	13.24	4.70	53.54	51.13	17.24	24.49	96.47
Childhood Heritage	Experienced	M	22.73	12.22	10.94	44.77	44.49	11.09	27.62	65.63
		F	15.84	9.00	1.65	41.60	80.02	48.50	6.67	179.97
	Novice	M	18.56	9.82	9.11	37.92	26.06	14.40	9.10	52.50
		F	12.83	8.09	1.9	27.42	82.37	30.05	10.70	120.19
L2 Learner	Novice	M	13.32	7.36	5.75	29.79	20.88	10.16	9.67	34.88
		F	42.87	42.22	2.67	236.30	43.95	38.05	2.44	172.28
Experienced	Experienced	M	15.34	8.03	7.91	34.24	29.96	22.94	9.06	85.47
		F	33.10	36.02	4.09	136.91	60.40	41.67	2.39	149.52
		M	34.12	24.32	9.05	114.96	34.13	21.56	9.63	84.46

By observational analysis, among female participants producing tense stops, the VOT values for adult and childhood heritage speakers are shorter, and thus closer to the native speaker results, than are the VOT values for second language learners. Similarly, among female participants producing lax stops, the VOT values of native speakers and adult and childhood heritage speakers are long, while those of second language learners are shorter. However, experienced female second language learners' VOT values for lax stops were longer, and thus closer to native speaker values, than were their novice counterparts' VOT values.

When fit to a general linear model carried out in the program SAS, results indicated that native speakers reliably used VOT to produce the difference between tense and lax stops, at $p < .0001$. Groups that equally reliably used VOT to produce this difference were all levels of adult and childhood heritage speakers. By contrast, novice second language learners did not reliably use VOT to produce the tense lax difference, at only $p = 0.4475$. After a longer period of instruction in Korean, however, experienced second language learners used VOT equally as reliably as heritage and native speakers to produce the tense lax distinction, at $p < .0001$. Figures 1, 2, 3, and 4 demonstrate the similarities between VOT production by native speakers and even novice heritage speakers, the differences between VOT production by native speakers and novice second language learners, and the notable movement towards a native-like VOT contrast between novice and experienced levels of second language learners.

Figure 1: VOT values of Native Speakers

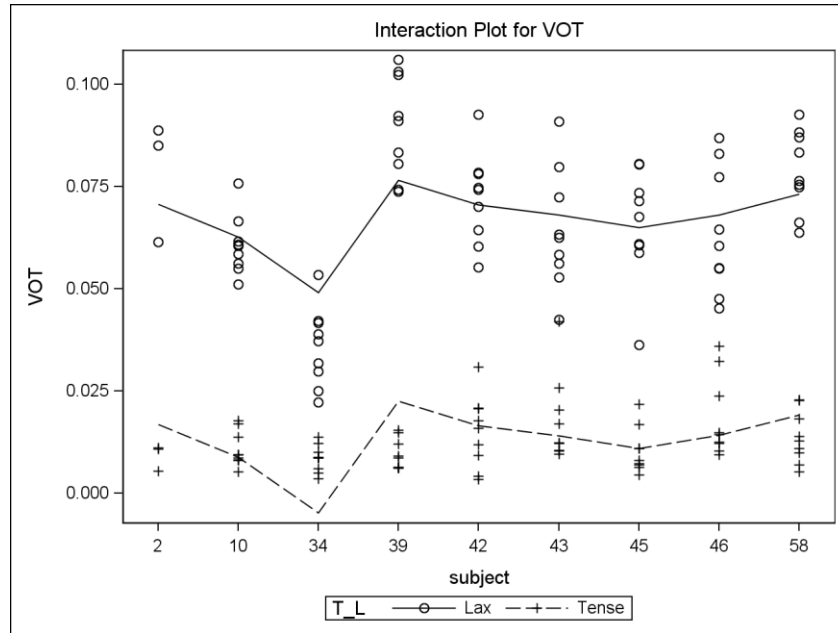


Figure 2: VOT values of Novice Childhood Heritage Speakers

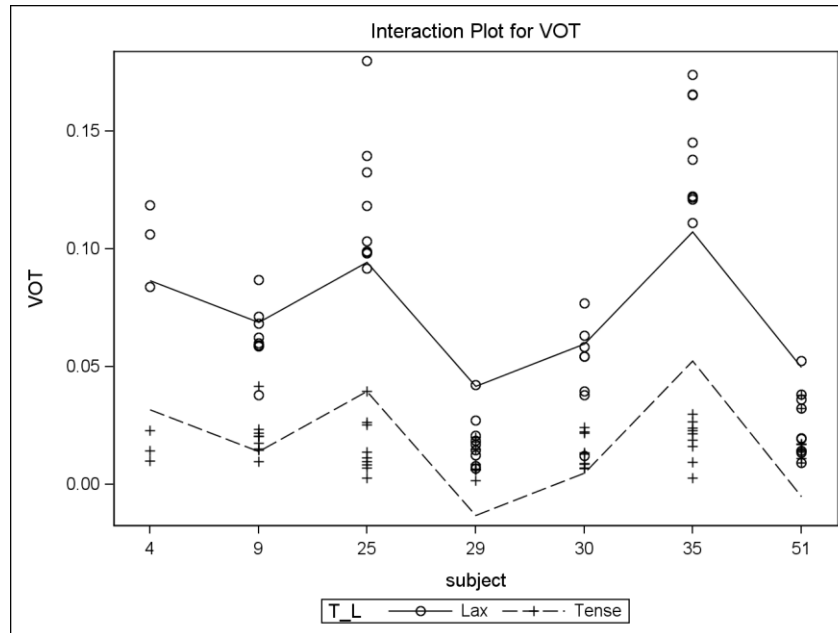


Figure 3: VOT values of Novice L2 Learners

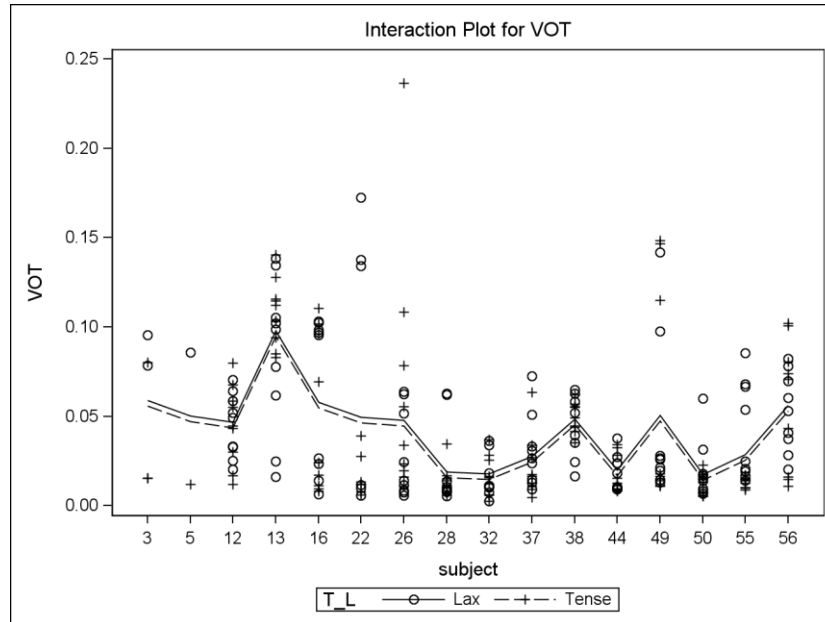
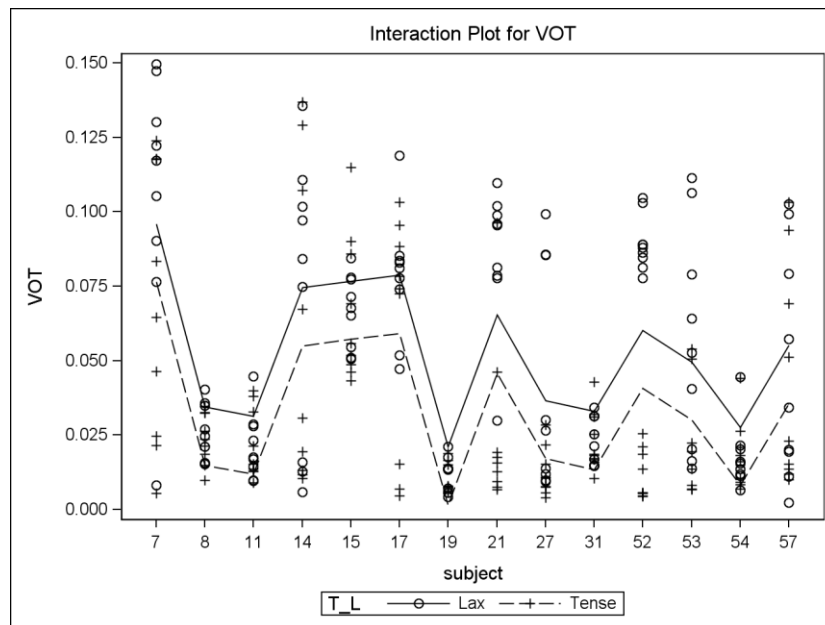


Figure 4: VOT values of Experienced L2 Learners



The figures shown and results described above indicate that all participants with significant Korean language experience during childhood, regardless of later language use, were able to reliably use VOT to create the contrast between tense and lax stops, while second language learners needed prolonged instruction in order to build their

sensitivity to producing the Korean VOT values needed to distinguish between different types of stops.

To compare tense VOT values across different speaker groups, a least squares means analysis was used. This analysis showed that second language learners of Korean at both novice and experienced levels produced tense stops at VOT values that were significantly different from those of native speakers and adult heritage speakers. However, experienced second language learners' tense VOT values were not significantly different from those of childhood heritage speakers. In addition, novice and experienced childhood heritage speakers' tense VOT values were not significantly different from those of adult heritage speakers. This would suggest that second language learners do make some progress in adjusting their Korean tense stop VOT values to be more native-like after prolonged instruction. Further, it appears that childhood speakers' production of native-like tense stop VOT values does not suffer after a prolonged gap in speaking Korean during late childhood and adolescence.

f0 Production Across Speaker Types and Levels

Using Praat, f0 of the vowel following the target stop was measured by calculating the mean f0 of the entire vowel. While analyzing VOT of tense and lax stops was relatively straightforward, accounting for f0 is less straightforward because the pitch of the vowels following the stops varies based on the natural pitch of the speaker's voice. Due to the variation in speaker vocal pitch, it is not useful to compare f0 across participants, even of the same sex. To account for natural speaker variation, f0 data was analyzed by calculating the average difference in Hz of f0 values of tense and lax stops for any one speaker as well as for that speaker group. Mean differences in f0 values

between tense and lax stops for each speaker group are shown in Table 3. Again, data for male speakers and experienced childhood heritage females is not particularly reliable due to the small number of these participants in the study.

Table 3: f0 Data

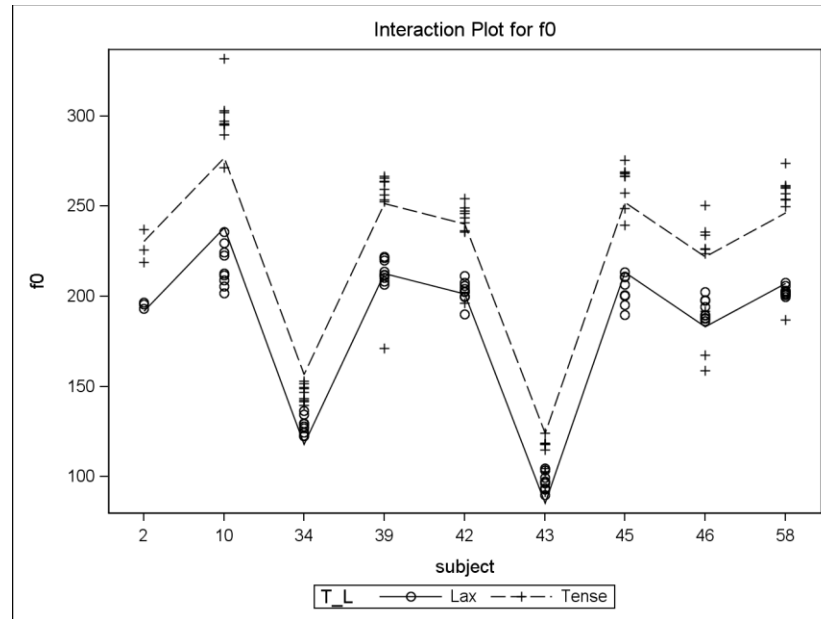
		f0 Difference in Hz (Tense-Lax)			
			Mean	Min	Max
Native Speaker	-----	F	44.71	15.55	88.24
		M	16.61	13.67	18.90
Adult Heritage	Novice	F	37.29	-39.53	86.57
		M	28.76	3.21	47.38
	Experienced	M	20.89	17.06	24.22
Childhood Heritage	Novice	F	30.11	3.00	60.12
		M	-0.89	-3.50	2.54
	Experienced	F	24.24	-7.88	46.73
		M	5.91	-0.90	18.46
L2 Learner	Novice	F	3.41	-22.77	35.30
		M	4.33	-2.13	15.34
	Experienced	F	9.37	-25.18	66.90
		M	-0.49	-19.24	15.25

By observation, among female participants, native speakers without any exception produced vowels after tense stops at a higher frequency than vowels after lax stops. Both adult and childhood heritage speakers seem to have also used a higher vowel pitch after tense stops. Second language learners, however, produced a much smaller difference in vowel pitch after tense or lax stops.

Due to the small number of male participants and the presence of f0 as a factor in both male and female speech, data from males and females was combined for the

purposes of statistical analysis. Native speakers reliably used f_0 to produce the difference between tense and lax stops, at $p < .0001$. Figure 5 shows an analysis of average f_0 of tense and lax stops by speaker. Visually, tense stops are produced at a consistently higher pitch than are lax stops.

Figure 5: f_0 values of Native Speakers

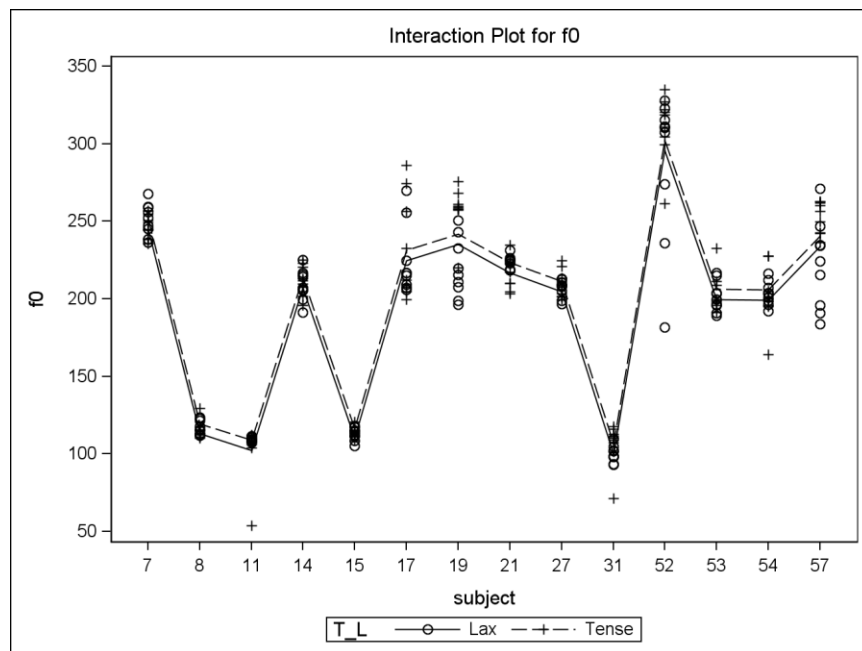


Adult and childhood heritage speakers also reliably used f_0 to produce the difference between tense and lax stops in Korean. All adult heritage speakers and novice childhood heritage speakers did so at $p < .0001$, but experienced childhood heritage speakers surprisingly did so with marginally less significance, at $p = 0.0073$. However, the comparatively smaller number of participants in the experienced childhood heritage speaker group may have contributed to this result, as each speaker had a greater impact on the compiled data for that group.

Second language learners also reliably used f_0 to produce the difference between tense and lax stops, but at a lesser significance than heritage or native speakers. Novice

second language learners did so at $p=0.0266$, while their experienced counterparts did so at $p=0.0036$. However, it is readily apparent in Figure 6 below that second language learners did not differentiate tense and lax stops in the same way as native speakers. On average, native speakers produced tense stops at 38.96 Hz higher than lax stops, while experienced second language learners produced tense stops on average at only 6.6 Hz higher than lax stops.

Figure 6: f0 values of Experienced L2 Learners



While the difference in f0 of tense and lax stops produced by second language learners was not strictly at-chance, there may be other factors at play creating the higher pitch rather than ascribing a high or low tone to tense and lax stops as native speakers of Korean do. One possibility is that second language learners of Korean perceive tense stops as “louder,” and thus may slightly and inadvertently raise the pitch by attempting to put stress on a syllable that begins with a tense stop.

Overall, data from native speakers showed, as expected, that Korean tense stops are produced with short VOT and high f₀ of the following vowel, while lax stops are produced with long VOT and low f₀ of the following vowel. That their results accurately reflect decades of Korean phonetic data (Lisker & Abramson 1964; Han 1998; Cho et al. 2002) made the native speaker group used in this study a reliable benchmark by which to judge the other groups' production of tense and lax stops. It appears that adult and childhood heritage speakers' stops are not significantly different from those of native speakers in terms of f₀ and VOT, while second language learners', especially novice second language learners', are significantly different. It also appears that ability to produce native-like Korean VOT values increases with increased instruction for second language learners.

TASK III: CATEGORICAL PERCEPTION

The categorical perception task aimed to answer three questions. First, did different groups use VOT and f₀ to distinguish between tense and lax stops? Second, how did heritage and second language learner responses compare to native speaker responses, especially after a longer period of formal instruction in Korean?

For the purposes of analysis, the results for responses to stimuli created from recordings of tense stops were excluded. The reason for excluding this data from results is that it represented a small portion of overall responses unequal to the amount of stimuli sourced from recordings of lax stops. Further, the stimuli sourced from recordings of tense stops all had short VOT values, with only f₀ changing between each stimulus. Therefore, including the data from these stimuli in the same analysis with responses to lax stimuli would inaccurately give more weight to 'tense' responses.

The stimuli created from tense stops were created to assess whether native speakers identified sounds as tense or lax at similar rates if the only difference between them was the tense or lax classification of the original recording. If the native speakers identified stimuli sourced from recordings of tense stops as tense more than they did the same stimuli sourced from recordings of lax stops, then it is likely that VOT and f_0 are not the only important perceptual cues for differentiating the tense/lax distinction in Korean.

As expected, this was the case. While native speakers identified 93% of all stimuli sourced from recordings of tense stops (all with 8 ms VOT) as tense, Figure 7 shows that they only identified 44.8% of corresponding stimuli sourced from recordings of lax stops as tense. Similarly, adult heritage speakers identified 88.4% of tense-sourced stimuli as tense, but only 61.3% of lax-sourced stimuli. Second language learners' responses did not differ by what type of recording the stimulus had been sourced from. This suggests that additional perceptual cues that native and heritage speakers can recognize besides VOT and f_0 remain present in the stimuli sourced from recordings of tense stops even after they have been manipulated, supporting Cho et al.'s (2002) study examining acoustic and aerodynamic correlates of Korean stops.

Although it is apparent from the responses to stimuli from different source recordings that there are other perceptual cues at play apart from VOT and f_0 , responses to stimuli created from recordings of lax stops still show their perceptual importance. As displayed in Figures 7 and 8, the perceptual results for native speakers show that both f_0 and VOT play a role in differentiating tense and lax stops; as f_0 increases and VOT decreases, 'tense' responses increase.

Figure 7: Native Speaker responses to stimuli from lax stop recordings by VOT

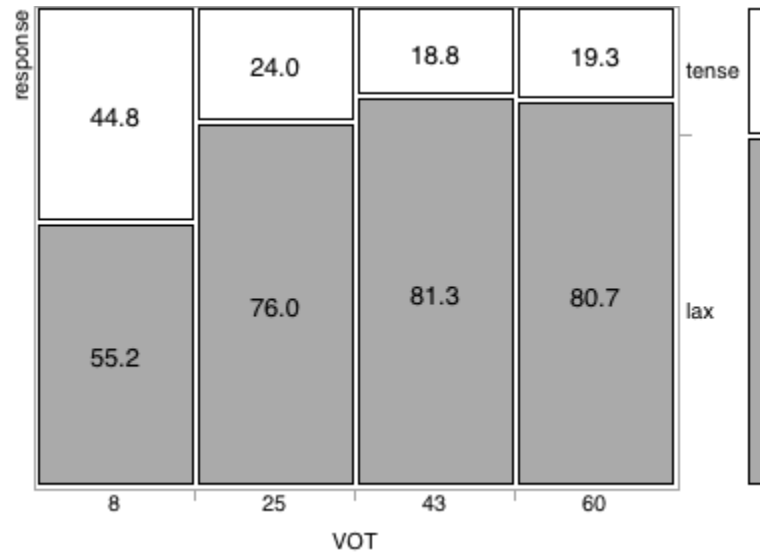
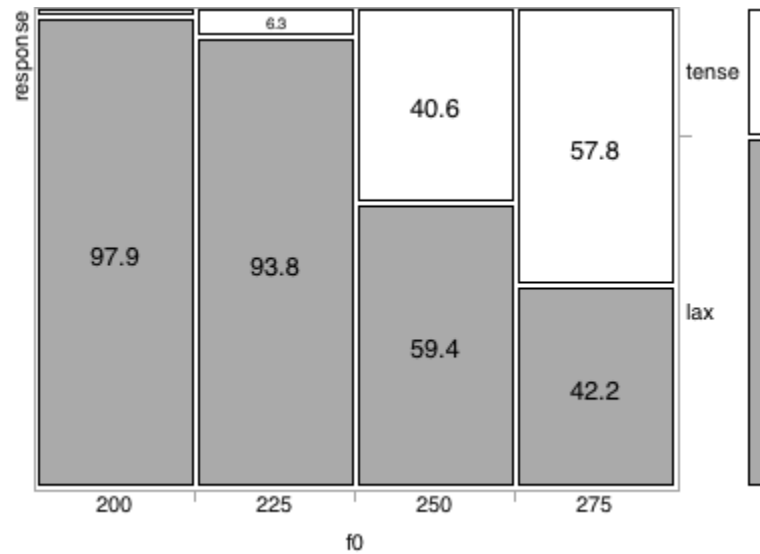


Figure 8: Native Speaker responses to stimuli from tense stop recordings by f0



VOT Perception Across Speaker Groups and Levels

Using a logistic regression model, results show that native speakers, as well as all speaker groups except for novice second language learners, reliably used VOT to distinguish between tense and lax stops. For all of these groups, $p < .0001$, with the exception of novice childhood heritage speakers, at $p = 0.034$. Novice second language

learners were the only group who did not reliably use VOT as a perceptual cue, at $p=0.0914$.

Perceptual results by VOT of stimuli were also compared across speaker groups. The differences between responses of group by VOT were mostly profoundly insignificant, with the marginal exception of stimuli with a VOT value of 25 ms. The only groups whose responses significantly differed from native speaker responses at 25 ms VOT were second language learners, with novice speakers at $p=0.0039$ and experienced ones at $p=0.0348$. These results would suggest that all speaker groups make use of VOT to distinguish between tense and lax Korean stops. However, one possibly confounding factor is the reluctance of native speakers to identify a stimulus with VOT of 8 ms as tense unless the stimulus itself was created from an original recording of a tense stop. Figures 9 and 10 show rates of novice second language learner responses by VOT of the stimulus as compared to rates of responses from their experienced peers.

Figure 9: Novice L2 Learner responses by VOT

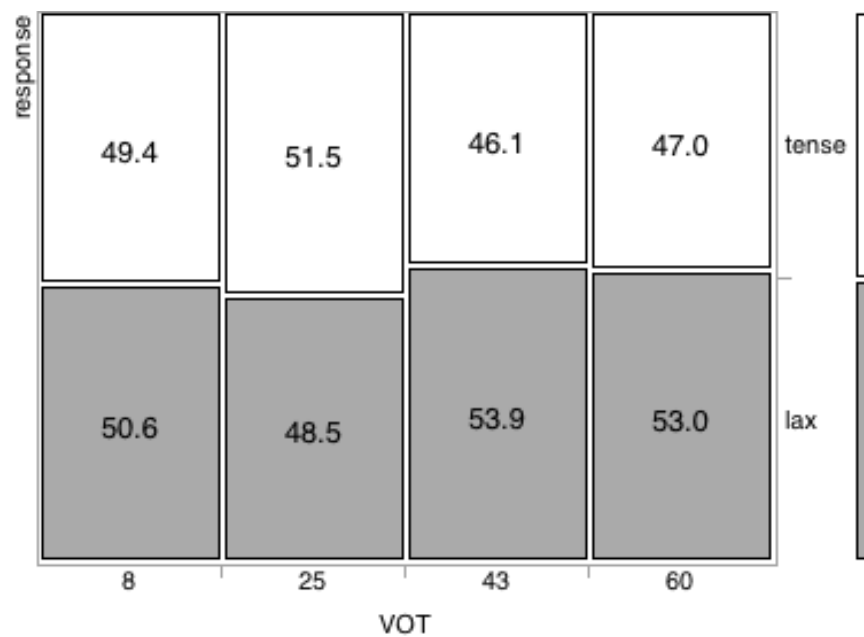
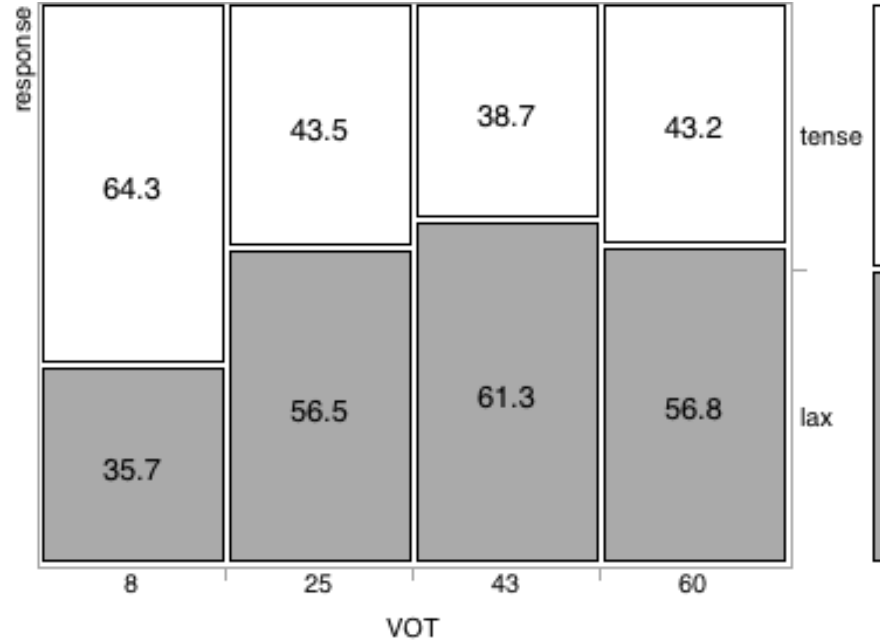


Figure 10: Experienced L2 Learner responses by VOT



Pitch Perception Across Speaker Groups and Levels

Using a logistic regression model, results show that native speakers reliably used pitch (f_0) to distinguish between tense and lax stops, at $p < .0001$. While each difference between the four f_0 values significantly influenced native speaker tense and lax identifications, the transition between 225 and 250 Hz showed the highest significance in affecting responses, at $p < .0001$

Similarly, adult and childhood heritage speakers of all instructional levels also reliably used f_0 as a perceptual cue differentiating tense and lax stops, each at $p < .0001$. By contrast, neither novice nor experienced second language learners of Korean were able to reliably use f_0 to distinguish between tense and lax stops ($p = 0.3055$ and 0.5591 , respectively). These results appear to show that childhood heritage speakers of Korean

do not lose the ability to use f_0 as a perceptual cue despite prolonged gaps in speaking experience in late childhood and early adolescence.

To determine whether different speaker groups used f_0 to similar or different degrees to distinguish between tense and lax stops, a generalized linear mixed model was used. The results of this analysis showed that responses from different groups differed significantly from each other when f_0 values were 200 or 225 ($p < .0001$), but were insignificantly different at the higher f_0 values of 250 or 275 ($p = 0.4885$ and 0.4255 , respectively).

At 200 Hz, the lowest frequency of stimuli, novice adult and childhood heritage speakers as well as novice and experienced second language learners' responses varied significantly from native speaker responses. At 225 Hz, the above groups with the addition of experienced childhood heritage speakers all varied significantly from native speaker responses. No group's responses varied significantly from native speaker responses at 250 or 275 Hz, but this has less to do with accuracy of student group responses and more to do with the marginal rate at which native speakers were willing to definitively rate a high f_0 stimulus as tense if that stimulus was manipulated from a recording that originally contained a lax stop.

CHAPTER 5

CONCLUSION

This study aimed to expand upon Oh et al.'s (2003) study by examining the effect of childhood speaking experience and continuity of speaking experience past childhood on speakers' abilities to utilize both f_0 and VOT to perceive and produce the difference between Korean tense and lax stops. While the present study did not include the "heritage overhearer" participants that were featured in Oh et al.'s (2003) study, its results may be extended to assess such speaker groups in the future.

The prediction of the present study was that childhood speakers of Korean would have a higher potential for relearning native-like Korean phonology than would their second language learner classmates at similar instructional levels. A secondary prediction was that adult heritage speakers' perception and production of Korean phonology would not significantly differ from that of native Korean speakers. Each of these predictions was supported. Childhood heritage speakers' perception and production abilities were nearly native-like even at novice instructional levels, despite the fact that they did not strictly speaking "improve" more quickly than second language learners, their perceptual and productive abilities far exceeded their second language learner counterparts.

Childhood heritage speakers' results were interesting in that they produced tense and lax stops similarly to native speakers despite ostensibly having low retrieval strength for production due to their prolonged gaps in Korean production during late childhood

and early adolescence. Through the lens of Bjork & Bjork's (1996) New Theory of Disuse, such a result lends itself to one of two explanations: either the childhood heritage participants spoke enough, even minimal, Korean to maintain retrieval strength for production, or their strong retrieval strength for perception bolstered their ability to retrieve productive skills that had been long neglected. A third possibility is that storage and retrieval strength are not separated by different modes of use; however, results from Oh et al.'s (2003) study that showed remnants of only perceptual abilities in childhood overhearers makes this last explanation unlikely.

IMPLICATIONS

During the questionnaire portion of the study, many second language learner participants indicated that their age of onset for Korean was neither during early childhood nor during college. In these cases, participants were asked about the nature of their first exposure to Korean. In all such cases, participants who reported first exposure to Korean in early or middle adolescence identified Korean media and pop culture as their method of exposure before enrolling in college courses.

Despite consuming Korean pop culture, most participants whose first exposure came in the form of music, movies, or television did not begin to study Korean until college. This means that some participants had up to five years of very regular exposure to Korean, with some reporting up to five hours per day of exposure. The effect on later phonology of consuming pop culture in an unfamiliar language is unclear; however, these participants were overall far more confident in their Korean language skills than their peers who began exposure to Korean in college. Some participants even used Korean non-word vocalizations during their data sessions with the researcher. It is unclear

whether the apparent increased internalization of Korean phrases and sounds resulted from the same high motivation for absorbing Korean language and culture that led these participants to seek out Korean media, or from the lower age of onset that Korean media provided them. Given that the second language learners who consumed Korean media and pop culture made more Korean exclamations and vocalizations than even some native speaker and heritage speaker participants, it seems likely that their high motivation, rather than their relatively low age of onset, contributed to their linguistic success. While further exploration is necessary to identify the role of Korean media on native-likeness of phonology, the results of this study imply that interest and investment in Korean pop culture positively influenced participants' attitudes about their own language use.

In addition to suggesting that media consumption can be beneficial for second language learners, the present study holds implications for educational policy. From a phonological standpoint, it seems that a prolonged gap in speaking experience is not detrimental to heritage speakers who spoke Korean during early childhood and who still have regular exposure to Korean. In view of this, it may not be harmful for public schools to promote an English-only policy during classes. Similarly, parents of Korean language heritage speakers may be reassured that their children will not lose phonological native-likeness in Korean if they choose to speak English at home.

Finally, the results of this study hold implications for how students should be assigned to heritage or non-heritage classrooms. Considering only phonology, it does not appear to be detrimental to include a childhood heritage speaker in heritage class sections provided that the individual student feels comfortable with the placement. Based on the

results of this study, such a student's perceptual and productive phonological abilities should be at a native-like or near-native-like level from the onset, so their performance on tasks like dictations and speaking assessments should not be at a disadvantage compared to their adult heritage speaker peers.

FUTURE CONSIDERATIONS

As became apparent during the perceptual portion of this study, even taking two primary perceptual cues into account still does not paint the whole picture of what influences native speaker decisions during phoneme discrimination. Additional perceptual cues, such as those explored in Cho et al.'s (2002) study, deserve further consideration when exploring the meaning of native-likeness as it relates to Korean phonology.

In addition, a longitudinal study of Korean language students' development of native-like perception and production of Korean phonology would be ideal as it could provide extremely concrete results indicating student improvement on an individual as well as group level. Collecting data from the same student participants as they move through novice and advanced classes would allow for a closer analysis of factors such as age of onset and motivation that were beyond the scope of this study. In addition, the present study had some limitations involving speaker availability across groups. Experienced heritage speakers were difficult to recruit for the study given that many students only take one year of foreign language courses as their university requires and do not continue long enough to be categorized into the experienced category. Longitudinal research would mean that fewer heritage speaker participants at the

experienced instructional level would be less problematic as these participants' results could be directly compared to their previous results as novice learners.

CLOSING REMARKS

The present study has provided support for the idea that perception and production of Korean stops by second language learners can be improved with further instruction. In doing so, it also provides support for Bjork & Bjork's (1996) New Theory of Disuse, which asserts that second language students are building both storage and retrieval strength for perception and production through continued language instruction. In addition, the support for Bjork & Bjork's (1996) New Theory of Disuse may extend to childhood heritage speakers if perception and production are viewed through separate lenses.

Incorporating perceptual and productive cues like f_0 into research in addition to commonly used cues like VOT assisted in gearing this research towards languages, like Korean, that are perceptually far from English.

To close, by providing evidence that heritage speakers of Korean possess native-like phonological perception and production despite having widely varying past and present linguistic experiences, the present study provides a sturdy platform from which further research analyzing learning and relearning of Korean phonology by heritage speakers and second language learners may proceed.

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APPENDIX A
QUESTIONNAIRE

- (1) What is your age?
- (2) What is your gender?
- (3) Where were you born (city, state or province, nation)?
- (4) Where were you raised (i.e. mostly spent the first ten years of your life) (city, state or province, nation)?
- (5) Where are your parents from (city, state or province, nation)?
- (6) What language(s) were spoken in your home when you were growing up, and by whom?
- (7) At what age did you begin to be regularly exposed to Korean?
- (8) What language(s) did you speak daily before the age of five?
- (9) What language(s) did you speak daily after the age of five?
 - a. After the age of ten?
- (10) What do you consider your native language(s)? (A native language is one you learned and spoke while growing up.)
- (11) What other languages, if any, do you speak fluently?
- (12) Would you define yourself as a “heritage speaker” of Korean?
- (13) Approximately how often do you hear Korean (hours per day or week)?
 - a. When did this frequency of exposure begin?
- (14) Approximately how often do you speak Korean (hours per day or week)?
 - a. When did this frequency of speaking begin?
- (15) How would you rate your current performance in the following areas of Korean:

(1= very low, very obviously not a native speaker)

(7= very high, like an educated native speaker of my age)

a. Listening

1 2 3 4 5 6 7

b. Speaking

1 2 3 4 5 6 7

c. Reading

1 2 3 4 5 6 7

(16) *If different from above, how would you rate the highest performance you ever previously had in the following areas of Korean? Please note the age of the highest performance next to each skill type.*

(1= very low, very obviously not a native speaker)

(7= very high, like an educated native speaker)

a. Listening (Age:)

1 2 3 4 5 6 7

b. Speaking (Age:)

1 2 3 4 5 6 7

c. Reading (Age:)

1 2 3 4 5 6 7

(17) How many semesters of Korean courses have you taken (high school level or above)?

a. When did you take these courses (semester and year)?

APPENDIX B

PRODUCTION TASK

Please read the following sentences at a natural pace.

- 1) 이것은 다다.
- 2) 까가 좋다.
- 3) 이것은 가다.
- 4) 빠가 좋다.
- 5) 바가 좋다.
- 6) 이것은 따다.
- 7) 이것은 까다.
- 8) 다가 좋다.
- 9) 이것은 바다.
- 10) 가가 좋다.
- 11) 따가 좋다.
- 12) 이것은 빠다.